

Clarifying the Role of Drought Adaptation Strategies on Changing Farming Mode by Livestock Farmers: Evidence from Komijan Township, Iran

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ABSTRACT

The current empirical research was conducted to investigate the impact of drought on livestock production with the main objective of studying the role of adaptation strategies in the process of changing the farming mode from crop-oriented to livestock-oriented by farmers in Komijan Township, Iran. Komijan has been facing a long period of drought that has affected farming systems of the area. Primary data were collected through interview using a questionnaire. The statistical population of the study consisted of livestock farmers in the area (N= 1,000), out of which 200 people were selected. The participants in research were interviewed using simple random sampling and Descriptive–Correlation research method. Logistic regression was used as the main statistical technique. Logit function with an odds ratio of 70.4% showed that strategies of shifting livestock as well as production management were the main responses of the farmers to drought conditions. Those farmers with a high level of perceived vulnerability were more capable of adapting themselves to drought than the others. Hence, perceived vulnerability is associated with production or farming mode.

Keywords: Descriptive–Correlation research, Perceived vulnerability, Production Mode, Strategy.

INTRODUCTION

Various measures have been adopted by the governments to slowdown global mean surface temperature increase, but the current climate conditions and demand of social development would cause global temperatures to continue to rise over the next 20–30 years (Wang *et al.*, 2018). Drought has been one of the most effective factors affecting the whole life of many resource-poor farmers across the world. Small farming systems are more susceptible to drought risks than market risks as they have weak linkages to the market. Drought is a condition under which levels of water in rivers, lakes, and ground tables are declined and there is insufficient soil moisture in farming areas. Drought is defined as a

protracted period of deficient precipitation resulting in extensive damage to crops, resulting in loss of yield. (NDMC, 2008). It can also be defined as a temporary climatic anomaly with no rain, especially during the planting and growing season. It is one of the most complex and least understood of all-natural events, and affects more people than any other hazard (Ansari Amoli *et al.*, 2015). According to some statistics, since 1900, more than 11 million people have died as a consequence of drought and more than 2 billion have been affected by drought, more than any other physical hazard (FAO, 2013).

Global warming also affects evapotranspiration, which is expected to lead to increased drought in dry areas as well as the expansion of dry areas. Precipitation has

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declined in the tropics and subtropics since 1970. Southern Africa, the Sahel region of Africa, southern Asia, the Mediterranean, and the US. Southwest, for example, are getting drier. Scientists expect the amount of land affected by drought to grow by mid-century—and water resources in affected areas to decline as much as 30 percent. (UCS, 2011). Along with many countries, Iran has been affected by climate change and is gradually changing into a dry and drought-prone country, located in the arid/semi-arid zone of Asia (Foghi, 2003). Iran has been heavily affected by drought events. For example, a particularly severe drought occurred during 1999-2002. This drought inflicted \$3.5 billion in damage, killed 800,000 head of livestock and dried up major reservoirs and inland lakes. This resulted in a decrease in cultivation and yield of cereal crops (Ansari Amoli et al., 2015).

According to an estimate of the Management and Planning Organization in Iran, total damages to the national economy resulting from drought during 1998-2001 were over \$7.5 billion (Garshasbi, 2015). Reports of other countries reveal the severe effect of drought on national economies. Kulshreshtha et al. (2003) estimated the economic costs of the droughts of 2001 and 2002 to the regional and national economy of Canada. According to their study, the lost Gross Domestic Product (GDP) was estimated at C\$3.65 billion and a loss of 23,777 jobs. Horridge et al. (2005) in their study indicated that the 2002-2003 droughts caused an overall reduction of Australian GDP by 1.6%, of which 1% was directly related to the agricultural sector, and the remaining 0.6% was due to multiplier effects. Several studies show significant short-run economic losses from the 2011 or 2012 drought including an annual national study by Anderson et al. (2012) in Texas and regional analyses made by Bauman et al. (2013), Guidry and Pruitt (2012), Watkins (2012), Wallander et al. (2013), and Dhoubhadel et al. (2015) in different parts of the USA. Diersen et al. (2002) also examined the economic impacts of drought in South Dakota. Their original estimate of total impacts amounted to \$1.8 billion.

Livestock production systems in developing countries are changing rapidly in response to a variety of factors such as climate change (Thornton et al., 2009). Drought impacts on livestock differ from livestock mortality, poor-productivity, to health and fertility (Rathore, 2005). Various studies reported a negative impact of drought on the livestock sector. The results of a study conducted by Udmale et al. (2014) showed that decrease in yield of cereals, horticultural crops, livestock production, and loss of employment, all of which were associated with decreased income of farmers, were the immediate economic impacts of drought. This study indicated that 45.7% of the respondents believed drought had resulted in lack of water and fodder for livestock. Also, drying of water resources, crop failure, increase in food prices, poor health—and a decline in prices—of livestock were the most immediate impacts of drought perceived by farmers. Drought mainly affects the crop and livestock production, therefore, approximately 79% of farmers preferred not to sell their crop production and, instead, they stored it to deal with anticipated droughts. About 47.9% of farmers stored crop residues to meet the fodder demand during the anticipated drought, and 51% of farmers reduced their expenses and saved money.

For drought management, there are alternatives, the most important of which is an adaptation to climate change (Smit and Wandel, 2006; Wise et al., 2014; Hertel and Lobell, 2014). Adaptation is essential for changing conditions, stress, hazards, risk, and opportunities in the future. Adaptation refers to a process, an action, or an outcome in a system such as household, community, group, sector, region or country, to better cope with the facing problems (Wang et al., 2018). It should be noted that adaptation is a dynamic process formed by institutional, cultural, and socio-economic systems (Amaru and Chhetri, 2013). Also, the ability to adapt to diversity and climate change is closely related to vulnerability. In the developing countries, there is a high level of vulnerability and low adaptability to factors such as reliance on natural resources (World Bank, 2000), the

limited financial and institutional capacity to adapt (Beg *et al.*, 2002, Deressa *et al.*, 2009), and low per capita income and the lack of safety networks (Desanker *et al.*, 2001).

Drought usually causes long-term impacts on perennial crops and livestock productions. The negative impacts in these cases might linger for multiple years (Ding *et al.*, 2011). In many parts of the world, the livestock sector has been affected by drought. Results show that short-term drought effects, including increases in crop and forage prices, are in tandem with decreased live cattle prices resulting from drought-induced beef cattle herd liquidation in the US (Leister *et al.*, 2015). Anderson *et al.* (2012) reported that, in Texas State in the USA, livestock losses due to the 2011 drought were estimated to be \$3.23 billion. Losses include the increased cost of feeding livestock due to the lack of pastures and ranges, and market losses. Diersen and Taylor (2003) estimated that the drought of 2002 in Missouri caused a total direct loss of \$251 million in the agricultural sector (the combined crop and livestock losses).

According to Mpandeli and Maponya (2014), low rainfall resulted in decreases in agricultural activities including a shortage of drinking water, loss of both livestock and crops, and lack of grazing capacity in South Africa. As reported by Mpandeli (2014), droughts across the Limpopo Province of South Africa impacted crop and livestock production on top of impact on water supplies for irrigation activities, mining, and domestic use. Maponya (2013) further highlighted that due to this severe drought impacts across districts in Limpopo Province of South Africa, grazing and water for livestock and irrigation activities were negatively affected. It was also highlighted by several experts that the drought impacts in the Sekhukhune district of South Africa not only affected the crop and the livestock smallholders, it also affected the vegetation status in the district. The quality and status of vegetation can be severely affected by drought periods. Livestock smallholder farmers in some of the areas in the district were also using the destocking, especially during uncertainty periods. Other

smallholder farmers in the district planted early maturing crop varieties to counteract any natural vagaries (Mpandeli *et al.*, 2015).

Speranza (2010), Opyio *et al.* (2015), and Wetende *et al.* (2018) indicated that frequent droughts are associated with the deterioration of livestock condition, increased incidences of certain diseases and livestock deaths, altered herd structure, and a collapse of livestock markets. The survey results show that 22% of livestock mortalities were associated with starvation from drought events. Studies by Huho and Mugalavi (2010) and Nkedianye *et al.* (2011) reported a positive correlation between drought severity and the magnitude of livestock losses in northern Kenya. In drought incident in 1999, the Management and Planning Organization in Iran estimated the costs of such impacts to be about \$1.25 Billion of which more than 80 percent constituted damages of crop, ranges, and livestock (Garshasbi, 2015).

Punsalma (2006), in a study in Mongolia, found that 53% of the respondents had lost more than half of their animals, 17% of which had lost all animals due to drought disasters. Drought in Mongolia was not regarded as a natural disaster, unlike many African and South Asian countries. However, drought results in the decrease of pasture plants, the decrease of palatable species in pasture plant, reduced water availability, and absence of grass on pasture. Also, drought prevents herders from preparing hay and other supplementary feed for animals and dairy products for themselves. Most importantly, animals are unable to build up the necessary strength (i.e., calories/fat) during the drought period in summer to enable them to cope with the harsh winter and spring windstorms and, therefore, they die in large numbers.

Livestock farmers in different areas have attempted to adapt themselves to drought condition. Their ability to adapt consists of a number of fundamental attributes that are relevant across a range of threats. In fact, drought shocks or livestock disease evolve and require proper accounting of the dynamic adjustment process (Dorfman and Lastrapes, 1996; Gramig and Horan, 2011). Some



smallholder farmers in Zimbabwe, for example, have been known to sell their livestock to compensate for lack of income because of insufficient harvest (Phillips *et al.*, 2002; Adger *et al.*, 2002; Patt and Gwata, 2002).

Udmale *et al.* (2014) found that farmers seek various options such as migration for employment, selling of livestock, and non-agricultural income sources to lessen the drought impacts. To mitigate the drought impacts, farmers used various drought preparedness and adaptation measures. With anticipated drought, farmers stored crop harvest (grains), stored crop residues for livestock, saved money, migrated for employment, sold livestock for income generation (and also because they were unable to provide food and water for the livestock), and sought alternative source of income through employment under NREGA [National Rural Employment Guarantee Act 2005 (or, NREGA No 42, later renamed as the "Mahatma Gandhi National Rural Employment Guarantee Act", MGNREGA), is an Indian labour law and social security measure that aims to guarantee the 'right to work], labor for local construction work, and mining, etc. A study in Kenya showed that agro-pastoralists' responses to drought were reactive and mainly involved intensifying the exploitation of resources and the commons. Proactive responses, such as improving production resources, are few. To improve adaptive capacity, interventions should expose agro-pastoralists to other forms of savings, incorporate agro-pastoralists as agents of change by building their capacity to provide extension services and maintain infrastructure. Securing livestock mobility, pasture production and access is crucial under the variable social-ecological conditions (Speranza, 2010)

Moreover, many livestock keepers have traditionally been capable of adapting to threats to their livelihood. Indeed, one of the most widespread livestock systems in Africa, pastoralism, has often been defined by its capacity to adapt to climatic uncertainty and other hazards. For other farmers, livestock

keeping is itself an adaptation to risk. In some of Africa's drier areas, pastoral communities are following the tried-and-tested adaptation strategy of shifting from less resilient (but more marketable) cattle and sheep into the more resilient camels and goats. Meanwhile many non-livestock farmers are investing in livestock as an adaptation strategy, usually starting with small stock and often feeding them with crop residues or household waste (IUCN, 2011).

Training is important to develop the adaptation capabilities of farmers, as is access to financial services and markets. According to the Standardized Precipitation Index derived from long-term rainfall data obtained from the Kenya Meteorological Service, extreme drought events were increasingly frequent and had negative impact on pastoral livelihoods. In order to adapt to or cope with climatic anomalies, households are using a variety of strategies. In addition to the traditional short-term coping mechanisms, the long-term adaptation strategies used include diversification of livelihood sources, livestock mobility to track forage and water resources, diversification of herd composition to benefit from the varied drought and disease tolerance, as well as fecundity of diverse livestock species, and sending children to school for formal education as a long term investment expected to pay back through income from employment (Opiyo *et al.*, 2015).

In East Africa, the communal land tenure system is pivotal to livelihood security because it allows livestock mobility to take advantage of pasture and water resources that are only seasonally accessible (Kameri-Mbote, 2013). Turkana herders own a wide range of indigenous livestock species, which are selected based on survival and productivity and are well adapted to the prevailing climatic conditions (Notenbaert *et al.*, 2007). To cope with the negative effect of drought and climate change, some pastoralists diversify their economic strategies to include agriculture, wage labor, and beekeeping, among others (Swift, 2001; Watson and van Binsbergen, 2006). Pastoralists may take the strategy of keeping herds containing a mixture of different

livestock species with variable levels of resilience to drought as insurance against total loss of livestock in case of drought (Opiyo *et al.*, 2015). Also, they indicated that the majority of the respondents (59.2%) viewed mobility as an adaptation strategy to reduce risk, and also to access livestock, markets, or urban centers. Discussion with key informants confirms that herd mobility enables opportunistic use of resources and helps minimize the effects of droughts, disease outbreaks, and livestock losses through raids. Movement of livestock to areas with secure water and pasture resources is an effective strategy against droughts (Niamir-Fuller, 2000) and has remained important for herders in northwestern Turkana County of Kenya. Meanwhile, the desired adaptation strategies proposed by the majority of respondents include establishing strategic livestock feed reserves, irrigation farming, development of water sources and insurance for livestock, and saving schemes. Many respondents also expressed interest in establishing grain and fodder storage facilities, improving livestock breeds, making livestock products such as ghee for sale during the dry season, and increasing their herd size (Opiyo *et al.*, 2015). Amamou *et al.* (2018), in empirical research, showed that the attitudes of the farmers towards adaptation to climate change are associated with farm typology. They focused their attempts mainly on increasing water capacity for livestock and crop production and improving livestock and housing conditions. In Iran, apart from farmers, the government took some measures to mitigate the negative impact of drought. For example, due to repeated drought, the Iranian government implemented the Aid and Rescue Program, in 2003. This Program was approved as part of the Third Five Year Development Plan. The government provided facilities to adopt water management technologies and supplied food and forage. Also, long term loan and subsidies to farmers were provided for increasing adaptation and control of drought risks (Garshasbi, 2015). Heat distress suffered by animals will reduce the rate of animal feed intake, resulting in poor growth performance

(Rowlinson, 2008). The objectives of the Emergency Drought Recovery Project in Iran are to alleviate the impact of current drought through measures to regenerate crops and livestock productivity, improve rural roads and potable water supplies to generate current income for affected populations (Ansari Amoli *et al.*, 2015). Drought vulnerability is related to the degree of natural and social adaptation to drought in terms of resistance and resilience (Ansari Amoli *et al.*, 2015). Iran is one of the countries located in the arid belt of the earth in which drought occurs frequently. Livestock production is increasing in Iran, driven by urbanization, more demand for animal protein, human population growth, and enhancing living standards.

Markazi Province is a region in the country that has experienced 13 successive years of drought. Komijan County in the Markazi Province is one of the locations that have been highly affected by drought and face groundwater scarcity as a consequence. About 50 percent of rural households are involved in livestock production in Komijan. Livestock provides money and food security for them and is a source of socio-economic security for rural households. They consider livestock as a source of savings, which is readily released at the time of economic crisis.

Livestock sector of this area has been affected by frequent drought conditions during the past years. The successive drought has put the livestock farmers into many constraints such as water scarcity, increased temperature, and reduction of fodder and feed production at farms. Some external factors such as overuse of groundwater by digging illegal wells, lack of receiving their customary water from Gharechy River has deteriorated the situation for mixed farming systems. It seems that sustainable development of the livestock sector is an effective adaptive strategy that represents opportunities for mitigating drought consequences in the area. Out of different livestock production system, extensive mode grazing animals in the pastures and farms, which is expanding in the area, has a negligible share to the output of greenhouse gases and, if well managed, can contribute to



conserving the biodiversity of rangelands and environmental health. Meanwhile it is noticeable that insecure tenure in rangeland areas, the condition of the vegetation, conflicts between new pastoral groups shifted to mountainous locations and weakening or breakdown of customary governance institutions are basic threats to the strategy of shifting from intensive to the extensive mode of livestock production. Many of the basic capabilities of livestock farmers are weak, leading to their vulnerability to drought. Hence, new and innovative measures are required to strengthen the capacity of the livestock sector for adapting their business to the threat of drought. Taking the above issues into account, this study aimed to investigate the drought-adaptive strategies applied by farmers in the area of study.

MATERIALS AND METHODS

The applied research is non-experimental and is a descriptive correlation research that the research data were collected by survey method. The statistical population of the study consisted of about 1,000 livestock farmers of Komijan Township. Daniel formula (Daniel, 1999) was applied to determine sample size:

$$n = \frac{NZ^2p(1-p)}{d^2(N-1) + Z^2p(1-p)}$$

Where, n = Sample size with finite population correction, N = Population size, is equal to 1,000, Z = Z statistic for a level of confidence, is equal to 1.96, P = Expected proportion (in the proportion of one), is equal to 0.2, d = Precision (in the proportion of one) is equal to 0.05.

According to the Daniel formula, 200 livestock farmers were selected as a sample and interviewed. Given the relative homogeneity of the respondents in terms of farming mode, simple random sampling was used to reach the actual samples. A questionnaire was developed by the researchers for collecting the needed data. Content validity of the main scales of the questionnaire was approved by a panel of experts' judgment from the Faculty of

Agricultural Economics and Development, University of Tehran. The reliability of the main scale of the questionnaire was approved by the Cronbach Alpha coefficient, which was 0.764. This amount is acceptable and shows that the instrument of measurement is reliable. This research was designed with the main objective of investigating the effect of applying adaptation strategies to cope with the drought consequences on production mode of livestock farming in the area of study.

RESULTS

Personal Characteristics of the Respondents

The findings showed that the mean of the respondent's age was about 54 years with a standard deviation of 13.07. The youngest farmer was 27 years old and the oldest one was about 85 years old. Majority of the respondents had a family size of three persons with the median equal to four persons at the time of the study. Frequency distribution of the respondents with regards to education level indicated that 46.5 percent of them were illiterate and 37 percent had basic literacy skills, 13.5 percent gained guidance school level degree, 2.5 percent had a high school diploma, and .05 percent had a higher degree. The data revealed that the main job of 49.5 percent of the respondents was crop farming followed by 25 percent livestock farmers and eight percent were involved in service-related jobs. All the respondents were engaged in animal husbandry affairs as either their main jobs or their second jobs. Also, about 17.5 percent of the respondents shifted their jobs from crop farming into animal husbandry due to the ever-increasing prevalence of drought. Livestock possession of the respondents was converted into the animal unit where one animal unit was considered as equal to the value of an average-weighted sheep (equal to 50 kg) in the area of study. According to the data, each respondent possessed about 87 animal units with a standard deviation of 117.62. Meanwhile, 85 percent of the

respondents possessed less than 150 animal units. The respondents had an average of 5.16 and 4.35 hectares of irrigated and rainfed lands, respectively. During the past decades, some of the irrigated lands have changed from irrigated mode into rainfed-type due to drought exposure.

In order to determine the main adaptation strategies to cope with drought conditions by livestock farmer, 27 items were identified and included in exploratory factor analysis. Kaiser-Meyer-Olkin measure was equal to 0.67 and *Bartlett's test* was significant at 1% level with the statistic equal to 561.380, showing that the data was appropriate for factor analysis. With the Varimax Rotation in the principal component analysis, the items were classified

into five factors determining about 57.939 percent of the variance of the data, as shown in Table 1.

The logistic test was used to determine the effect of strategy's dimensions on the adaptability of livestock farmers to drought. According to the Chi-square statistic, which was equal to 23.065 with eight degrees of freedom and being significant at one percent level, function performance is better when using predictor variables than using constants alone. The results of the Logit likelihood regression model indicated that the overall predictive power of the model (67.5%) was quite high, while the significant Chi-square ($\chi^2 = 23.065$, $P < 0.01$) was indicative of the strength of the joint effect

Table 1. Factors determining the main adaptation strategies to cope with drought conditions.

No	Factor name	Item	Factor loadings	Eigenvalue	Percent of variance determined
1	Livestock transfer to another place	Livestock mobility in long distances for getting water	0.828	2.259	14.12
		Moving animal to mountainous pastureland with enough water	0.814		
		carrying water tank along with a flock	0.729		
		Paying more attention to housing health	0.699		
2	Production management and adaptation	A long-term and comprehensive program for water provision	0.656	1.857	12.70
		Selling sick and old-aged livestock constantly	0.652		
		Applying extension worker's and veterinarian's advice	0.598		
		Expanding lands under fodder cultivation by better water management	0.700		
3	Defensive strategy and future visioning	Pay more attention to animal disease and preventive healthcare measures	0.608	1.857	11.60
		Livestock insurance	0.603		
		Using credit for improving livestock production units	0.565		
		Water spraying to animal stands	0.788		
4	Improving physical condition of keeping animals	Improving animal feeds with nutrient supplements	0.607	1.658	10.36
		An increasing number of fattening livestock in the flock	0.549		
		Using indigenous medicines for livestock treatment	0.754		
5	Return to traditional methods	Changing flock composition into drought-resistant animals	0.728	1.464	9.15



of the covariates on the probability of adaptability of changing production mode among farmers in the area of study.

Also, -2 log likelihood was equal to 190.18 and significant, showing independent variable predicts dependent variable efficiently. The classification power of the model was equal to 70.4%, indicating that out of 182 samples, 133 people were correctly classified. According to Table 2, logit function is expressed as following:

$$\ln(p/(1-p)) = -1.85 + 0.193(X_1) + 0.149(X_2) - 0.021(X_3)$$

Where, P stands for an odds ratio of shifting to animal husbandry as a response to drought, X_1 refers to the strategy of livestock transfer to another place, X_2 stands for the strategy of production management and adaptation, and X_3 refers to the extent of vulnerability. The results revealed that the variable of “strategy of livestock transfer to another place” had a β value of 0.193 with a significant Wald statistic at one percent level. In addition, EXP (B) was equal to 1.213, indicating that those farmers who adopted this strategy to cope with drought were ready to shift from crop farming to livestock production 1.213 times more than the other farmers. The results indicated that the variable of “strategy of production management and adaptation” had a β value of 0.149 with a significant Wald statistic at one percent level. In addition, EXP (B) was equal to 1.16, indicating that those farmers

who adopted this strategy to cope with drought were ready to shift from crop farming to livestock production 1.16 times more than the other farmers. The results showed that the variable of “strategy of production management and adaptation” had a β value of -0.021 with a significant Wald statistic at one percent level. In addition, EXP (B) was equal to 0.98, indicating that those farmers who had higher perceived vulnerability of drought were ready to shift from crop farming to livestock production 0.98 times less than the other farmers.

DISCUSSION

Climate change is one of the recent challenges faced by different countries and communities. Consequences of climate change such as emission of greenhouse gases and livelihood transformation have affected many aspects of life in various communities throughout the country. In the study area, at the first step, the farmers decided to adopt the strategy of transferring their flocks from the village to areas less affected by drought so that they can better adapt to climate change. As the second strategy, the farmers decided to change their production mode and shift from highly irrigated cropping system to rainfed farming system as well as from crop farming to livestock production, and from mixed farming to a grazing system. They have also

Table 2. Coefficients of logit function of shifting to livestock production as a response to drought condition.

Independent variable	B	SE	Wald	Sig	Exp (B)	The confidence level for Exp (B) at 95 %	
						Lower	Upper
Livestock transfer to another place	0.193	0.056	12.060	0.001	1.213	1.088	1.353
Production management and adaptation	0.149	0.067	5.019	0.025	1.161	1.019	1.322
Defensive strategy and future sighting	-0.038	0.053	0.522	0.47	0.962	0.867	1.068
Improving physical condition of keeping animals	0.013	0.092	0.019	0.891	1.013	0.846	1.213
Return to traditional methods	-0.122	0.110	1.219	0.269	0.885	0.713	1.099
Vulnerability level	-0.021	0.008	6.656	0.010	0.980	0.964	0.995
constant	-1.856	1.25	2.203	0.138	0.156	-	-

changed their flock composition from large ruminants to small ruminants, which are more mobile and can be easily moved to mountainous areas with rich pasture. The study conducted by Seo and Mendelsohn (2008) had similar findings. In addition to the above strategies, livestock farmers decided to improve their infrastructure for animal raising and reconsider using their indigenous knowledge and experiences as the main sources for coping with drought side effects. These findings are in line with the results of Alary *et al.* (2014), Nordone *et al.* (2010), and Thornton *et al.* (2009).

The empirical model of the study revealed that those farmers who were capable of adopting strategies of livestock transfer, as well as changing farming practices and mode of their production, were ready to develop their animal husbandry units and reduce crop farming activities as a response to drought condition and lessen the perceived socio-economic vulnerabilities of their livelihood. This is in line with the findings of Thomas *et al.* (2007). These results indicate that adopting a strategy depends on the perception of farmers about its effectiveness in reducing burdens of their lives. Given the status of animal husbandry to reduce farmers' vulnerability under drought conditions, government intervention in the process is recommended by subsidizing economic and business consultancy services to improve or revise business models of the farming households in order to strengthen both livestock farming sector and non-farming activities simultaneously. In fact, the farmers need to adopt new business models that are more sustainable and effective in reducing their vulnerability to climate change.

The strategy of transferring livestock from plain areas to the mountainous rangelands changes the mode of production from mixed farming to the grazing system. In fact, the responses of livestock farmers to drought has been reactive because they have shifted livestock raising from the home-stead and farms to the grazing lands and mountainous areas. Although they are presently satisfied

due to the availability of fodder in new virgin places, it is predicted that pursuing of livestock grazing in the mountainous pastures will not be a sustainable adaptive strategy and may degrade vegetation resources in the long term. Hence, they need to consider more proactive strategies such as improving their capacities in fodder production and stewardship skills when it comes to pasture exploitation. These measures need full support and intervention of government to help livestock farmers by providing extension and advisory services, maintaining infrastructure, securing their access to essential inputs and use of common resources. Accordingly, the area needs a comprehensive livestock development plan in which grazing of animals in pasture becomes more sustainable in the long term and farmers receive educational, technical, advisory and infrastructure services.

CONCLUSIONS

Climate change directs experts to look forward and redesign farming systems so that they become more adaptive to drought condition. This process engages farmers into a radical transformation of their practices, their way of reasoning and decision-making, and their participation in local knowledge production. In this way, the current research was designed to study variables that affect farmers' decision on changing their livelihoods. The findings revealed that farmers could not adopt a full grazing system because in some parts of the year they shift their animals to the villages due to insufficient fodder in the pasture or for other reasons such as security, access to fodder, etc. This implies that changing cropping pattern of the farms to enhance their capacities of fodder production will help the livestock farmers to produce the needed fodder and become less dependent on the market for the times they go for hand feeding animals. Wetende *et al.* (2018), in empirical research, showed that adaptation



options might become weak when they view the drought phenomenon through a narrow lens of disease control by regular spraying and maize stovers as supplementary livestock feed during fodder insufficiency periods. In addition, Bedeke *et al.* (2018) suggested that promoting household memberships in local organizations through facilitating mutual cooperation and communication among farming communities for adoption of climate change by changing production method is an effective strategy to improve their adaptive capacities. In line with the research findings of Opyio *et al.* (2015), the livestock farmers of Komijan keep dairy cattle to produce milk, which is partially consumed by the households or sold to the local market. They also sell small animals like sheep and goats when cash is required to meet other domestic requirements such as purchase of food or school payments.

The research findings revealed that production management and adaptation play a central role in changing livelihood of villagers to livestock production. Therefore, there is a need to an innovative farming systems management and functioning (Sautier *et al.*, 2017), which reinforces production management skills. In this way, Lacombe *et al.* (2018) suggested co-innovation, which supports practice-led innovations to back farmers' empowerment in an agroecological transition pathway. Empowerment and capacity building of the stakeholders, to enable them to learn and develop innovative practices or to form collective organizations, will support more agroecological practices. The research results showed that vulnerability of rural households to climate changes was a barrier to changing farming system. This is while livelihoods in rural areas is severely affected by climate variability, and this elevates the vulnerability of rural households to food insecurity. In this regard, Mohammed *et al.* (2018) revealed that highly vulnerable regions are characterized by characteristics such as low levels of productivity, low crop diversity, agriculture as the primary income

source, and a low level of agricultural insurance, which are partially a result of drought in the region. Therefore, farmers need to learn how to adapt themselves to drought condition. This study recommends that the government need to get involved in developing a model of climate-smart livestock production system in the area of study, through which livestock farmers can have access to the essential inputs, information, and technology to become more resilient to climate change. The knowledge obtained from these findings could be used for decision-makers and stakeholders to promote them to develop policies for livestock management practices that address climate change and make them more adapted to diverse farmers' decisions toward livelihood change. However, the results show that adaptation to climate change is happening in the complex socio-ecological system of livestock production in the study area.

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واکاوی نقش راهبرد های سازگاری با خشکسالی در تغییر شیوه کشاورزی توسط دامداران: مطالعه موردی شهرستان کميجان، ايران

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چکیده

این تحقیق به بررسی تاثیر خشکسالی بر تولیدات دامی پرداخته و با هدف اساسی مطالعه نقش راهبرد های سازگاری با فرآیند تغییر شیوه تولید کشاورزی از زراعت به دامداری توسط بهره برداران شهرستان کميجان در استان مرکزی به اجرا در آمد. کميجان یک دوره طولانی خشکسالی که نظام های بهره برداری منطقه را تحت تاثیر قرار داده تجربه کرده است. داده های اولیه با استفاده از یک پرسشنامه و روش مصاحبه به دست آمده است. جامعه آماری تحقیق شامل ۱۰۰۰ نفر از دامداران منطقه بود که از بین آنها ۲۰۰ نفر به عنوان نمونه برای مصاحبه انتخاب شدند. پاسخگویان با استفاده از روش نمونه گیری ساده تصادفی و روش پیمایشی مورد مصاحبه قرار گرفتند. رگرسیون لجستیک به عنوان روش آماری برای تحلیل داده ها مورد استفاده قرار گرفت. تابع لو جیت با برتری نسبی ۷۰/۴ درصد نشان داد که راهبرد های جابجایی دام و مدیریت تولید مهمترین پاسخ دامداران مورد مطالعه به شرایط خشکسالی بود. آن دسته از کشاورزان با سطح بالای آسیب پذیری درک شده توانمندی بیشتری برای سازگاری خود با شرایط خشکسالی داشتند. بنا براین آسیب پذیری درک شده با شیوه تولید مرتبط است.