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Camel production in Kingdom of Saudi Arabia: Economic and environmental impacts

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ABSTRACT

This research aimed to analyse the impact of land use elements, meteorological year (MY) (temperatures changes) and carbon dioxide (CO_2) emissions on camel numbers, prices and products, the study was adopted two sets of data termed as economic data and environmental data. Secondary data through years 1991∼2016 is approved with supportive primary data, which designed by researchers via personal interviews of the camel producers were used. Simple descriptive, matrix correlations and multiple linear regressions tools techniques were used to analyse the data. The study results confirmed that, all the owners of the camel are men. Furthermore, the percentages of the camel share to the total livestock are positively correlated with camel numbers ($r = 0.964$, $p<0.01$). However, the land use has a significant influence on camel share to total livestock and camel numbers. Increases in the agricultural and arable land use were resulted in a reduction of the camel numbers ($r = -0.458$, $p<0.01$ and $r = -0.814$, $p<0.05$; respectively). Moreover, the changes in MY had inverse effect on camel numbers ($\beta = -14839.52$) and milk production ($\beta = -1898.19$). Camel numbers, producers' prices and camel production were significantly effected by CO_2 emissions from industrial and energy sources. It concluded that, land use had highly significant impact on camel share to the total livestock population; however, climatic change significantly affects camel numbers, and camel production. Further studies of the camel economics knowledge were recommended.

Keywords: Meteorological year, CO_2 emission, camel product, land Use, KSA

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1 Introduction

General background The Kingdom of Saudi Arabia (KSA) was classified by the World Bank as a high-income country (WB, 2017); with a high Human Development Index (UN, 2013).The total population in KSA was 32.552 million in year 2017 (GSA, 2017). The Gross Domestic Product in 2016 was 2,580,820 Saudi Arabia Rial (SAR) compared with 2,545,236 SAR in 2015 (GSA, 2017). The per capita income of the country was 55,860 USD in 2016 (WB, 2017). Now a day, KSA is like other regions in world influences by the global economics crisis and this causes fluctuations in kingdom economy.

The compositions and wealth of national livestock resources in the KSA are camels, sheep, goats, cow, equines and chickens. Camels are extremely important livestock species in the arid and semiarid zones in Asia and Africa (Simenew et al., 2013). Camel production in KSA considers as one of the most popular national animal since last decades. The total gross live camels in KSA were declined through last periods equally about 301717 heads in 2015 compared with 248205 heads in 2016 (GSA, 2016; MAWE, 2015; FAO, 2018). The greatest percentages of the camel population recorded in Riyadh region, contributing about 21% of total camel in the country (MAWE, 2015). Economically, the camel meat and milk production consider as one of foremost foodstuff in KSA and played avital role in the livelihood of the people, particularly in the rural areas. Furthermore, camels use for other purposes such as racing and beauty pageant. The climate change especially global warming may highly influence production performance of farm animals throughout the world. Worldwide the emission of CO_2 increases annually. The total emissions of CO_2 in 2010 was more by 45% compared with 1990 (FAO, 2018). Globally, KSA recorded that the lowest percentage of CO_2 emissions was observed in 2015 (1.56%) compared with China (the highest emitter country, which estimated as 28.2%). As it is realistic that in last decades the entire world under focusing of the dramatically and uproar of climate changes. Rojas-Downing et al. (2017) discussed that climate change is a threat to livestock production. Moreover, livestock globally play a considerable role in climate change, in terms of their contribution to greenhouse-gas emissions (Steinfeld et al., 2006). From researches review, some international organizations like Research Program on Climate Change (CGIAR), Agriculture and Food Security (CCAFS), and International Livestock Research Institute (ILRI) are working to improve this knowledge.

Camels are the most important animals domesticated by humankind in the desert; the camel has a peculiar status: highly adapted to a specific ecosystem (the desert). The economic importance of this multipurpose animal is evident from the numerous benefits provided by camel products (meat, milk, wool). Moreover, the camel serves for riding, as a beast of burden and as a draft animal for agriculture and transport. In spite of these numerous services to humans, the camel subsector in KSA faces various challenges such as steadily increasing and creeping in drought, which leads to the disappearance of pastures and grazing lands. Beside, climate changes initiate and breakout various diseases threating health and habits of camel herds. Moreover, the prices of the camel and its products spark according to the changes in the national economics and climate changes. In addition to poor management, inefficient marketing channels, instability of camel prices and poor industry due to economic and social changes are face the camel production in KSA. However, increasing in population and changes of the food habits, most of residents in KSA are increasing demand of camel products, particularly meat products with numerous kinds and forms. Furthermore, there were less or no attention on camel researches would conducted for linking the economic characteristics of camel production and climate changes. Since the majority of researches conduct in KSA were focussed on the camel ecology, biology and physiology (El-Ziney, 2007; Musaadbr et al., 2013; Faye et al., 2014; Babiker, 2014), nevertheless some of the researchers suggested to perform further studies on the impact of climate changes on camel production (Chowdhury, 2015; Al-Jassim and Veerasamy, 2015).

The objective of this study was aimed to investigate the impact of the land use on the camel share to the total livestock and camel production. Likewise, the study directed to examine the changes of MY and the impact of CO_2 emissions on the camel numbers, producers prices and production, particularly meat and milk production.

Climate changes and livestock production KSA is predominantly vulnerable to climate changes as the most of its natural recourse deteriorated. The impact of climate change expects to affect all aspects of life in the KSA, including water resources, health, food and agricultural production, fisheries, biodiversity, forest and rangelands (Darfaoui and Al Assiri, 2010). The maximum temperature reaches about 45.5 °C in eastern region of the country in 2017 (MEP, 2018). MY was defined as a collation of selected weather data for a specific location during a specific year (Santos et al., 2003).

Several of the researches argued that the climate changes have undesirable impacts on economics and social features. Climate change consequently affects and threats livestock production in both directly indirectly ways. Climate change affects livestock directly through heat stress and increased morbidity and mortality and indirectly through quality and availability of feed and forages, animal diseases and grazing systems (Hopkins and Prado, 2007). However, at the same time, the livestock sector contributes significantly to climate change by increasing greenhouse gas (GHG) emissions. Previous study achieved by (FAO, 2016) discussed that, smallholder livestock keepers, fisher folks and pastoralists are among the most vulnerable to climate change. Recent analyses have shown that it is unlikely global temperature rises can be kept below two degrees Celsius without a shift in global meat and dairy consumption (Bailey et al., 2014). Higher temperatures, potentially caused by GHG, would likely result in a decline in dairy production (Baumgard et al., 2012). Similarly, Parsons et al. (2001) argued that high temperatures may reduce feed intake, lower milk production, lead

to energy deficits that may lower cow fertility, fitness and longevity. Heat stress seems to have adverse impact on both milk production and milk quality in camel (Al-Jassim and Veerasamy, 2015), water availability, animal reproduction and health (Rojas-Downing et al., 2017). From searches, founding about livestock and climate changes, the affiliation between the livestock sector and climate change is much more complex and generally ignored.

2 Methodology

2.1 Data collection and information

This study was conducted in KSA subsequently it is the richest country in Arab Peninsula. Quantitative macroeconomics secondary data on camel population, land use, climate, and camel production in KSA were obtained from collection of figures and information from published and unpublished sources from international, regional and national institutions were used in this study. The data were collected and labelled as, economic data and environmental data. The economic data including the macroeconomics data of the camel production categorised as the total camel numbers (in head), camel prices (in USD/head), camel meat production (in ton), camel share in total livestock (in percentage) and fresh milk produced by camel (in ton). Similarly, the data of the land use for agriculture (in thousand ha) and arable (in thousand ha) were collected. Whereas the environmental data including MY (the weather parameter is involved in this research is changes of temperature during the years 1991∼2016 in the study area) and two sources of CO_2 emissions identified as energy sources (from energy, manufacturing and construction industries and fugitive emissions) and industrial sources (from industry and products uses) were used in this research during years 1991∼2016. Moreover, primary data were obtained from primary interviews using structured questionnaires were administered to randomly selected camels producers and experts were adopted in this study. Focus group discussions and direct observations were applied to collect the data.

2.2 Tools of data analysis and models specifications

Various types of analytical techniques of analysis were achieved. Simple descriptive analysis was implemented to analyse the primary data. Matrix correlation analysis was implemented to measure the magnitude and strength between the various macroeconomics variables of camel production in the country, their sharing in the total livestock and land use. Furthermore, the multiple linear regression tool was adopted. The aim of regression equations were set to estimate the relationships among variables. That is, to estimate the conditional expectation of the dependent variable given the independent variables. The camel economic variables were denoted as the dependent variables while the climate variables were denoted as independents or predictors variables. Therefore, the regression analysis is to show in what way economics variables were changed according to the climate features. The multiple regression equations were constructed for each type of economic variables, separately.

2.3 Economic–climate linear models of camel production

Four types of equations were realized and consequently constructed regarding to natures of economic data. The MY data was introduced as independent variable. As well, the CO_2 emissions from industrial and energy sources were involved as independents variables. While camel numbers, producers' prices and productions (in terms of fresh milk and meat) were introduced as dependent variables. The multiple regressions models were set as follow:

$$Y_{Cn_i} = \alpha + \beta M_{y_i} + \beta_1 E_{I_i} + \beta_2 E_{En_i} + ei \quad (1)$$

$$Y_{Cp_i} = \alpha + \beta M_{y_i} + \beta_1 E_{I_i} + \beta_2 E_{En_i} + ei \quad (2)$$

$$Y_{Cm_i} = \alpha + \beta M_{y_i} + \beta_1 E_{I_i} + \beta_2 E_{En_i} + ei \quad (3)$$

$$Y_{Cmk_i} = \alpha + \beta M_{y_i} + \beta_1 E_{I_i} + \beta_2 E_{En_i} + ei \quad (4)$$

where Y_{Cn_i}, Y_{Cp_i}, Y_{Cm_i} and Y_{Cmk_i} denote the dependent variables for camel numbers (head), camel producers prices (USD t^{-1}), camel fresh milk (t yr^{-1}) and camel meat production (t yr^{-1}), respectively.

M_{y_i} = MY (in A °C); E_{I_i} = emissions of CO_2 (Gg) from industrial sources; E_{En_i} = emissions of CO_2 (Gg) from energy sources; β = coefficients or factors of MY; β_1= coefficients or factors of industrial emissions; β_2= Coefficient of energy emissions; α = constant term that represent the mean value of response variable in absence of all others interpreters (= 0); and ei = error terms.

3 Results and Discussion

3.1 Economics facts about camel production in KSA

The surveyed interviews results showed that the camel owners were males and the owned women basically were neglected. The surveyed respondents stated that camel historically kept for transportation and work, but currently the camels keeping principally for their meat and milk products and social aspects. Previously study conducted by Wilson (1998)

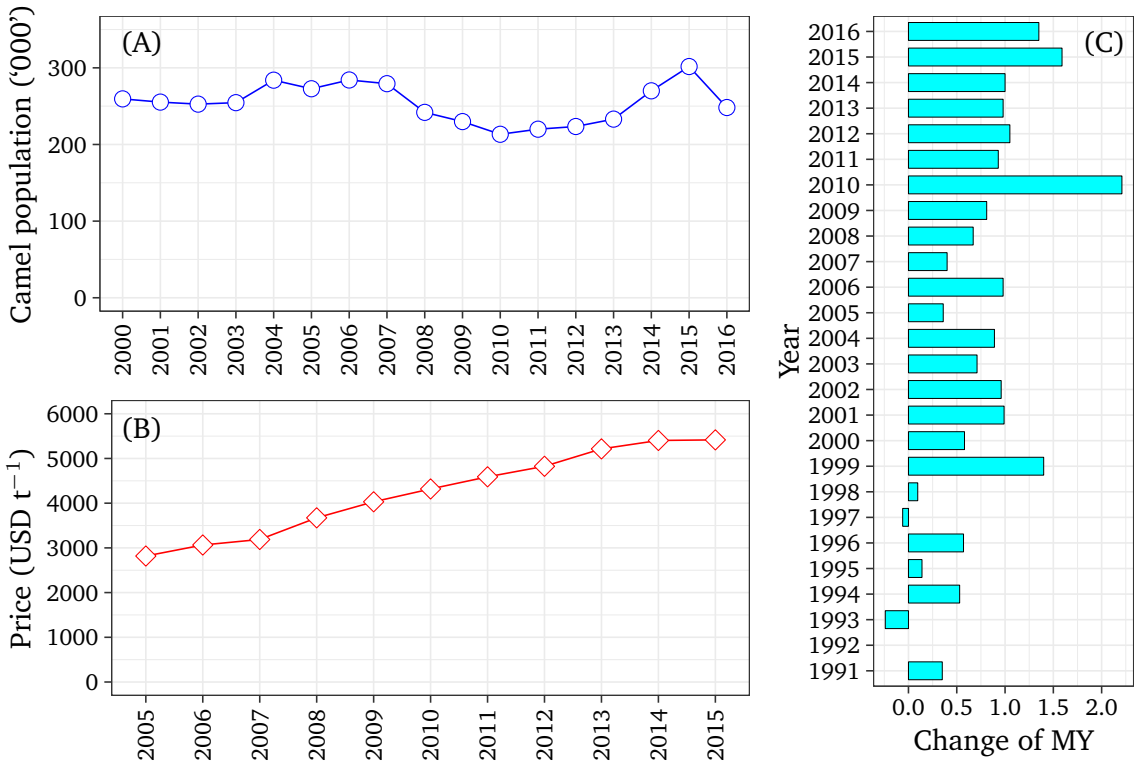

Figure 1. (A) Camel population ternd in Kingdom of Saudi Arabia (2000∼2016), (B) Camel producers' price trend in Kingdom of Saudi Arabia (2006∼2015), and (C) Change of MY (Temperature Parameter) in Kingdom of Saudi Arabia (1991∼2016)

confirmed that camels in the Middle East kept primarily for transportation and work rather than as a producer of meat, milk, or clothing.

Fig. 1(A) displays that trend of camel was fluctuating during the years 2000∼2016. The highest number of the camels recorded in 2015 and declined in 2016. However, the number of camels in 2016 was more by 7.5% in comparing with 2010. These results might be related to improvement of camel sector, farm development and population growth in KSA. The increase in country's population will definitely cause camel products in all forms to be increased. This result is in agreement with Abdallah and Faye (2012), they mentioned that the increase of milk and meat productivity of camel mainly linked to the population growth. Otherwise, Faye (2012) found that the decline of the camel population is uncorrelated to the development level of the country and there is no correlation between the camel population growth and the GDP/capita.

It is clear from Fig. 1(B) that the camel producer's price sharply increased during the years 2006∼2015 and declined during the year 2016. The increasing rate relates to constant increase in KSA population and to the increase in supply of the camel meat since most people prefer camel meat and it considers as the most important product from camel. The survey interview results indicated that the camel meat and milk had a positive impact on camel producers' health and life style of various tribes particularly in the rural areas. Saeed et al. (2005) stated that the camel meat and liver believes to have medicinal properties in the world. Likewise, Malik et al. (2012) argued that there is a traditional belief in the Middle East that regular consumption of camel milk helps in the prevention and control of diabetes.

3.2 Influences of land use on macroeconomic data of camel production

Livestock production alone accounts for 70% of the total agricultural land use, representing one third of all croplands and vast grazing areas (Steinfeld et al., 2006). Camel products, especially milk and meat, are highly appreciated by the local population. In KSA, efforts had made during the past decades to create the necessary infrastructure to realise the potential offered by camel breeding in the relevant zones. The camel share to the total livestock in KSA is about 6.34% in 2006. However, this percentage reduces to 5.26% in 2014. The study results reveal that there were negative linkages of the percentage of share of camel in the total livestock with the agricultural land use and arable land use. The arable land use was highly significant with respect to the percentage of camel share to the total livestock ($r = -0.930$, $p<0.01$). As

Table 1. Correlation matrix of the estimated parameters

Items†	SCL	AGLU	ARLU	CN	CMP	CMKP
SCL	1					
AGLU	−0.59**	1				
ARLU	−0.93**	0.55**	1			
CN	0.96**	−0.46*	−0.81**	1		
CMP	0.125	0.21	0.29	0.21	1	
CMKP	−0.188	0.15	0.15	−0.09	−0.07	1

† SCL= % Share of camel in the total Livestock, AGLU = Agricultural land use, ARLU =Arable land use, CN= Camel numbers, CMP= Camel meat production, CMKP= Camel milk production;
** = significant at 1% level of significance

Table 2. Camel production and environmental impact (1991∼2016)

Model†	Equation‡								F-value	R^2	Sig.
		α		βM_y		$\beta_1 E_I$		$\beta_2 E_{En}$			
Y_p (−1.8)	=	−100.15	+	182.10M_y (0.99)	+	0.21E_I (0.616)	+	0.11E_{En} (1.713)	24.35	0.811	<0.001
Y_{cn} (8.22)	=	512377.14	−	14839.52M_y (−0.699)	−	4.965E_I (−1.24)	−	0.258E_{En} (−0.358)	14.98	0.726	<0.001
Y_{cmk} (9.09)	=	91893.743	−	1898.19M_y (−0.551)	+	0.48E_I (0.075)	−	0.015E_{En} (−0.125)	0.27	0.047	0.84
Y_{cm} (7.44)	=	38021.86	−	989.981M_y (−0.568)	−	0.686E_I (−2.1)	+	1.04E_{En} (0.175)	1.77	0.236	0.19

† Values in the parentheses are T-values; ‡ For details about the model equations, see Equations 1∼ 4.

observes in Table 1 that when the arable land use was increased, the percentage of camel share production in the total livestock decreased significantly. In addition, the increase in the agricultural and arable land use caused reduction of the total number of camels (r = −0.458, p<0.01 and r = −0.814, p<0.05, respectively). Furthermore, there were highly significant relationship between the number of camels and percentage of camel share to the total livestock (r = 0.964, p<0.01). However, there were no relationship between milk or meat production with the land use (Table 1). Likewise, there were no significant correlations between the percentage of camel share production in the total livestock and camel products in term of meat and milk production (Table 1).

3.3 Influences of MY on macroeconomic data of camel production

From Fig. 1(C), it is obvious that there are extremely changes in the weather all over the KSA during the study periods. The weather became hotter during the years 2010∼2016. Similarly, the figure displays that the weather in the years beyond 1998 was colder than the rest of the years. It was clear that the year 1992 was the coldest year and the most vulnerable changes were observed in year 2010 (hottest one) during surveyed period (Fig. 1(C)).

Table 2 describes that the changes in MY have a negative effect on the camel numbers and camel products in KSA, β = −14839.52 (F = 14.98, R^2 = 0.726). This indicates that the number of camels affects significantly by climate changes. Similarly, there was a reduction in milk and meat production, but it was indirectly significant with change in climate. This reduction might be was attributed to, other factors affecting meat production like poor managements and emergence of new camel diseases. These results are in agreement with (Van den Bossche and Coetzer, 2008), they argued that climate change is expected to have direct and indirect impact on African livestock products. By concerning in reduction of milk production, our results agreed with Al-Jassim and Veerasamy (2015), who confirmed that if the drought condition prolonged, camels should showed reducing trends in milk production during heat stress conditions). However, the results in Table 2 indicate that, the MY significantly (positively) effected the producers prices, β = 182.10 (F = 24.35, R^2 = 0.811). Lamy et al. (2012) explained that climate as one of the most factors affecting livestock production and productivity. The observable impacts of the climatic change on the

camel stock include the expansion of the geographical distribution of the species, the use of the camel with its higher integration in mixed crop-livestock systems and the increased risk of emerging diseases (Faye, 2012; Megersa et al., 2012).

The global emission of CO_2 was the main causes of global climate changes and undesirable environment effect, which ultimately influenced the global economy. The study results reveal that the camel numbers negatively marked by the emissions of CO_2 from industrial process ($\beta_1 = -4.965$) and energy ($\beta_2 = -0.258$), F = 14.98, $R^2 = 0.726$. This indicates that the number of camels decline by the increase in both sources of emissions (Table 2). The producer's prices were increasing while there were highly significant increase in the industrial and energy emissions; $\beta_1 = 0.11$ and $\beta_2 = 0.21$; respectively (F = 24.35, $R^2 = 0.811$) this is a complex issue worldwide, according to climate change, prices of various crops and animals increased during last few years (WB, 2018).

Moreover, the results reveal that milk production were decreased as the emissions of CO_2 increased from energy sources ($\beta_1 = -0.015$). While the meat production was decreased as the emission of CO_2 increased from industrial sources ($\beta_2 = -0.686$). However, the reductions of milk or meat production were not significant with respect to CO_2 emissions, F = 0.27, $R^2 = 0.047$ (for milk production) and F = 1.77, $R^2 = 0.236$ (for meat production).

4 Conclusions

The study found approximately all camel owners were males and kept camel for meat, milk products, and social purposes and the camel numbers were played a significant role in the total share of the livestock in Saudi Arabia's economy. The land use had a highly significant impact on camel share to the total livestock and camel numbers. Increase in agricultural and arable land use would led to reduce the camel numbers. However, as an upshot of increasing CO_2 emissions, the number of camels declined while the camel producers' prices increased. Moreover, the study found that a reduction in CO_2 emissions was associated directly or indirectly with increasing in camel production. In conclusion, the study concluded that the climate changes have significant impact on the camel numbers and the producer's prices and have adverse impact on the camel production. The study greatly recommends for further studies in camel economics knowledges in KSA.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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