Chapter 15
Climate Change Adaptation and Mitigation Options for the Livestock Sector in the Near East and North Africa

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Abstract An assessment of the impacts of climate change and climate variability on livestock sector in Near East and North Africa (NENA) was undertaken to document impacts, past evidences, hotspots of climate change, projections and vulnerability of the sector, and measures to adapt to and mitigate climate change. This was done through an in depth analysis of literature, utilization of GIS tools and experiences in the region. NENA region is one of the driest regions in the world and is vulnerable to extreme climatic events such as droughts, sea level rise, floods, and storms of dust, sand and snow. Conservative predictions show that by 2050 the temperature will increase by 1–4 °C (avg. 2.4 °C) and precipitation will reduce by 8–29 % except in isolated areas of the Arabian Peninsula. Dry season will increase by 2 months in some countries and substantially reducing the length of time that the rangelands can support grazing animals. In the region the livestock sector shares 30–60 % of the agricultural output and contributes to food security and nutrition, poverty alleviation, employment and economic development, monetary saving, social security, living insurance and manure. Demand for livestock products is increasing due to the increasing population, urbanization and income growth. Nearly all countries of the region are net importers of animal and animal products. Smallholders will continue to depend on livestock for their livelihoods in the region.

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In 2006, FAO estimated that the livestock production systems, from feed imports to marketed animal products, generate directly and indirectly 18 % of global GHG emissions. However, the livestock systems have also great potential to climate change adaptation and mitigation. Adaptation and mitigation measures for the region's livestock sector are discussed. This paper advocates all concerned parties to take concrete actions to tackle the impacts of climate change on agriculture and food security.

Keywords GIS • Smallholders • Livestock production systems • Adaptation strategies • Mitigation strategies

15.1 Introduction

Climate change and climate variability have put the countries in the Near East and North Africa (NENA), where scarce natural resources are already under considerable pressure, at significant risk. NENA, one of the driest regions in the world, is vulnerable to extreme climatic events such as droughts, floods, sea level rise, storms of dust, sand and snow. The Intergovernmental Panel on Climate Change (IPCC 2007) predicts increases up to 4 °C over the short term and to 9 °C in the summer months in NENA by the end of the twenty-first century. A reduction in precipitation of 7–29 % is predicted, for example, in Syria, Iraq and Arabian Peninsula; and the dry season is expected to increase by 2 months (Evans 2009) hence reducing the length of time that the rangelands can support grazing animals. Sea levels rise would place coastal areas in Egypt, Kuwait, Libya, Qatar, Tunisia, and UAE at particular risk. Climate change is expected to exacerbate water stress and alter river flows. The region's vulnerability to climate change is aggravated by widespread poverty, particularly in the rural areas where 34 % of the population lives below the poverty line (IFAD 2010).

The Near East is one of the centers of domestication for several livestock species, with a high genetic diversity remaining today. Livestock contributes to food security, poverty alleviation, employment and economic development and shares 30–50 % of the agricultural output in the region. Given the aridity of the region, livestock is a prime component of rural livelihoods in the NENA. Dwindling water and feed resource base due to recurrent droughts, degradation of rangelands and desertification are major concerns.

The impacts of climate change on livestock are eminent with varying degree of vulnerability among sectors and countries. In addition to their role as source of food, transport, fiber and other useful products, these natural resources have great potential for climate change mitigation. However, they contribute about 18 % of the greenhouse gases (GHG) emissions which have to be dealt with. The aim of this paper is to describe the measures to adapt to and mitigate climate change in the region and address climate change impacts, past evidences, hotspots of climate change, projections and vulnerability of the sub-sectors, with a special focus on livestock, forestry, fisheries and aquaculture sectors.

15.2 Climate Change Impacts on Livestock Sector

Changes in temperature have been well documented in NENA. Recent studies (Zhang et al. 2005) using data from 75 weather stations of 15 countries in NENA disclosed significant increases in number of warm days and decreases in number of cold days, and revealed ample evidence of hotspots of impacts and vulnerability to climatic fluctuations in the Region (Celis et al. 2007; De Pauw 2008). The region also witnessed varying degree of extreme events such as droughts, floods, and sand and snow storms. In the north-eastern Syria, for example, herders lost almost 85 % of their livestock due to repeated droughts since 2005 (IRIN 2011).

Reduced precipitation and number of precipitation days in a year will add stress on already scarce water resources in many countries, and shift arable land into more arid rangelands, which would result in increased importation of water and feedstuffs or decreasing herd sizes. For example, a reduction in productivity of crops and shortage of water will be evident in Egypt and shortening of the length of growth period and number of freezing days would affect crops in Iran. It is expected that climate change will overall increase the interdependence of countries in respect to the access and use of genetic resources for food and agriculture (Fujisaka et al. 2011). Some of the projected changes in the region are summarized below.

Climate change impacts livestock production and health through changes in the quantity and quality of available feeds, heat stress, available water, livestock diseases and disease vectors, and genetic diversity (Thornton et al. 2009). A reduction in precipitation will result in the loss of natural pastures leading to a loss of adapted animal genetic resources. Accelerated feed shortages are likely to worsen the rangeland degradation further. A predicted loss of 25 % of animal production (Sequin 2008) relate to only reduced feeds and increased heat stress in the mixed crop-livestock system. Mapping and quantifying climatic data in combination with the spatial information on livestock production systems, livestock numbers and people was used to identify hotspots of change and vulnerability. Hotspots of vulnerability were identified where most people and livestock will be affected. Table 15.1 presents results grouped by livestock production systems, as adaption and mitigation options often will relate to these production systems.

15.3 Improving Adaption to Climate Change in Livestock Sector

Livestock producers have long been adapting to environmental and climate changes using herds of mixed animal species and breeds, widespread and seasonal pastures, splitting animals into discrete herds and mobility, and involving in other economic activities (McIntire 1991). However, increased urbanization, population growth, economic growth, consumption of animal source foods and commercialization made those existing coping mechanisms inadequate (Sidahmed et al. 2008). New approaches, technologies, and training to deal with climate change are now needed

Table 15.1 Projected changes in precipitation, temperature, vulnerable human and livestock population in the NENA

Production system	Countries	Precipitation reduces by	Temperature increases	Vulnerable rural people	Vulnerable livestock population
Agro-pastoral	MAR, TUN and ALG	11–28 %	2.2–3.3 °C	15–23 %	Sheep and goats ALG: 37 % TUN: 33 %
	EGY LIB		2.2–2.8 °C	EGY: 22 % LIB: 88 %	Sheep and goats EGY: 38 % LIB: 87 % Cattle EGY: 13 % LIB: 79 %
	Near East	Up to 20 %	2.3–3.1 °C	IRN: 29 % IRQ: 35 % JOR: 22 % SYR: 8 %	Sheep and goats IRN: 44 % IRQ, JOR and SYR: 24–38 % Cattle IRN and IRQ: 31 % JOR and SYR: 15 %
	GCC and YEM	↑7 % 24 %	2.2–2.9 °C		Sheep and goats OMN, QAT and YEM: 90 %; KWT and UAE: 50 %
Mixed extensive	MAR, TUN and ALG	ALG and TUN: 9–23 %, MAR: 8–26 % MAU: 15–29 %	ALG: 1.9–3.6 °C TUN: 1.6–2.8 °C MAR: 1.6–3.3 °C MAU: 2.3–3.2 °C	ALG: 71 % TUN: 65 % MAR: 70 % MAU: 16 %	Sheep and goats 30–59 % Cattle 41–61 %
	EGY LIB		2.2–2.8 °C	EGY: 22 % LIB: 88 %	Sheep and goats EGY: 38 % LIB: 87 % Cattle: EGY: 13 %; LIB: 79 %
	Near East	SYR: 18 % IRN and IRQ: 14 %	SYR: 1.7–2.3 °C IRN and IRQ: 2.5–3.3 °C	43–47 %	Sheep and goats SYR: ca. 50 % IRN: 35 % IRQ: 47 % Cattle SYR: ca. 50 % IRN: 39 % IRQ: 29 %

Source: Modified from Van de Steeg and Tibbo (2012)

ALG Algeria, *EGY* Egypt, *GCC* Gulf Countries Cooperation, *IRN* Iran, *IRQ* Iraq, *JOR* Jordan, *KWT* Kuwait, *LIB* Libya, *MAR* Morocco, *SYR* Syria, *TUN* Tunisia, *UAE* United Arab Emirates, *YEM* Yemen

as well as better policies and stronger institutions to manage natural resources sustainably. Adaptation strategies include:

(a) *Integrating crops and livestock* which allows better use of crop residues as feed and animal manure as organic fertiliser and/or source of bioenergy for biogas, and reduces pressure on rangelands and water resources. *Supplementary feeding* of animals is also needed especially for animals reared for market as rangelands provide only a third or less of their feed needs. Introducing drought-tolerant crops and shrubs and use of appropriate tree forages (Kitalyi et al. 2008) would also help rehabilitate rangelands and increase productivity of livestock.

(b) *Herd diversity* (Hoffmann 2010) by using multi-species and multi-breed and *herd splitting* into smaller manageable groups and moving them into different areas would buffer against climatic and economic adversities, prevent over-grazing and maintain the long-term productivity of rangelands (Nyariki and Ngugi 2002). *Mobility* has also been used for centuries by livestock keepers as a strategy to adapt to spatial and temporal variations in precipitation, though it can lead to problems of overgrazing, exposure to new diseases and parasites, resource use conflicts, etc.

(c) *Production and marketing strategies* involve a range of husbandry adjustments to counteract heat stress that may suppress feed intake, production, fertility, and survival rates (Pilling and Hoffmann 2011). Livestock *insurance* scheme based on index (Barrett et al. 2008) which compensates clients for the loss of animals or reduced productivity because of drought should be introduced. The scheme is based on cumulative precipitation, cumulative temperature, area average yield, area livestock mortality and related indices. Unlike traditional insurance a payout is based on an external indicator which triggers a payment to all insured clients within a geographically defined space (Ouma et al. 2011).

(d) *Adapted local livestock breeds* produce under conditions where other breeds cannot survive, resist or tolerate diseases, drought, water scarcity, stress from strong heat and solar radiation. They are also integral parts of their environment that help sustain biodiversity, as highlighted in FAO's *Global Plan of Action for Animal Genetic Resources* (FAO 2007). Most of the adapted breeds, however, are largely uncharacterized and their loss as a result of droughts and floods, or disease epidemics related to climate change may increase. To secure against such disasters, it is necessary to characterize animal genetic resources and subsequently to build inventories, including information on the spatial distribution of breeds and valuable breeding stocks and countries should have a plan for conservation programmes. Countries need to introduce animal identification and traceability as an important livestock management tool.

(e) *Modelling and forecasting emerging infectious animal disease and early warning systems* are crucial components for preparedness. Remote sensing satellite imagery is now being used to study a variety of environmental parameters in order to evaluate their potential to predict the emergence patterns of mosquito vectors of the *Rift Valley Fever* (Gould and Higgs 2009). *Bluetongue* is another important viral disease whose distribution is affected by the changing climate. Climate and environmental changes might deeply alter the transmission pattern and disrupt the local epidemiological equilibrium, as is expected for malaria.

The demographic growth of large cities and, more generally, the increase of human populations in NENA will result in more intense livestock aggregation around market areas, the merging of populations from different origins, and increased trade from sub-Saharan Africa to these regions. With periurban growth and climate change, some devastating outbreaks could happen due to the fact that the vector *Culicoides* deposits their eggs in stagnant or slow moving waters with rich organic material or dung. *Old World Screwworm* risk prediction identified hotspots in southwest Iran, southwest Yemen, and along the south coast of Oman, and observed areas with suitable conditions in parts of Syria, Lebanon, Jordan, along the Nile Valley in Egypt, and in relatively large areas of Sudan. The FAO coordinated Global Information and Early Warning System (GIEWS) and the Famine Early Warning Systems Network (FEWS NET) of USAID were developed to manage the risk of food insecurity through the provision of timely and analytical early warning and vulnerability information (http://www.fews.net/).

(f) *Appropriate policies and institutions* for coping with climate change are needed for assisting livestock keepers, farmers and rural communities manage droughts in dry areas. Policies need to provide supportive conditions for smallholder farmers and pastoralists through guaranteeing access to grazing land and water, and facilitating the provision of appropriate services and infrastructure. Livestock keepers should be represented in national and international decision-making bodies, a voice in policy-making.

15.4 Improving Mitigation Roles of Livestock Sector to Climate Change

(a) *Adjusting livestock numbers* to available resources, increasing individual animal resource use efficiency and optimization of feed rations and feed additives or other technologies may be primarily used to reduce methane excretion in ruminants. GHG from enteric fermentation change as production systems intensify and move toward higher feed use and increased productivity. Less GHG emissions are produced, for example, in beef cattle intensive feedlot systems and dairy farms. Emissions from extensive systems can be reduced through improved genetic potential of the animals, increased feed quality and manure management. Reducing livestock numbers is probably the only effective way to reduce GHG emissions in pastoral systems. Problems to be overcome in mitigation are incentive systems, institutional linkages, policy reforms, monitoring techniques for carbon stocks, and appropriate verification protocols.

(b) *Animal waste management*: GHG emitted from manure are mainly methane and nitrous oxide (Steinfeld et al. 2006). Raising animals on pasture is an efficient way to reduce methane emission from manure. In addition to production of renewable energy, reducing storage duration of slurry, especially in hot conditions, the treatment of manure, and improved spreading techniques could reduce GHG emission (Dourmad et al. 2008).

(c) *Intensifying livestock production systems* reduce emissions through (1) improved feeding management through the use of biotechnologies and additives and high quality feeds and concentrates; (2) selective culling of unproductive animals, breed selection, improved herd health and minimizing involuntary culling; (3) keeping browsing and grazing animals together, especially when feed is in short supply, to increase complementarities and make use of forage that cannot easily be used by other species; (4) improved feed conversion efficiency through appropriate practices including genetics, nutrition, reproduction or health improvement.

Challenges or constraints to livestock sector, climate change adaptation strategies, benefits of the adaptation, and policy implications or interventions are summarized in Table 15.2.

Table 15.2 Challenges, adaptation strategies, benefits of adaptation and policy implications

Constraints/challenges	Adaptation strategies	Benefits of adaptation	Policy intervention
Feed scarcity both in quantity and quality, high cost of feeds	Improve crop-livestock integration (nutrient cycling)	Improves productivity, income, food security	Policy to optimize number of animals with resources available
Rangeland degradation, species disappearance	Herd management (herd splitting, culling, species diversification or substitution)	Prevents rural–urban migration	Rangeland management policy, PES
Expansion of croplands	Rehabilitate rangelands (water harvesting, grazing management, re-seeding)	Prevents overgrazing, land degradation and repeated crop failures	Representing livestock keepers in policy dialogue
	Use alternative feed resources (feed blocks, cactus, fodder trees)		Policies to limit inappropriate expansion
Animal health problems			
Vaccination coverage is very low	Improve vaccination coverage through improved vet capacity	Improves productivity, income, food security	Cross-border cooperation in the prevention of trans-boundary animal diseases ADs and zoonosis as per the OIE regulations
Limited capacity in disease diagnosis	Improving capacity in disease diagnosis, disease monitoring and surveillance	Prevents loss of livestock assets, zoonosis, and rural–urban migration	
Limited capacity in disease monitoring and surveillance	Creating sub-regional capacity in disease forecasting diseases and linking to CC	Prevents disease spread and loss of income due to trade restrictions	
Limited capacity in forecasting diseases and linking to CC		Improves public health and welfare	

(continued)

Table 15.2 (continued)

Constraints/challenges	Adaptation strategies	Benefits of adaptation	Policy intervention
Limited market access			
Low price of animals	Use of producers groups	Improves income of producers	Policies that encourage competitiveness of smallholders
	Create market information system	Prevents rural–urban migration	Policies that encourage local products that serve certain niche markets (branding)
	Capacity building in value addition to primary products	Contributes to conserving adapted breeds	
Inappropriate policies, regulations, land use and tenure			Improve land use and land tenure policies
Droughts, increased transhumance, increased livestock trade, TADs	Index-based livestock insurance scheme	Keeps livestock keepers job; allows to feed animals during scarcity, prevents TADs	Establishing early warning systems
	Conserve feeds, strengthen veterinary quarantine system		
Urban and periurban system			
Urban encroachment	Manure management	Reduces GHG emitted	Animal waste management policy
Animal waste management	Incentives for organic fertilizer use, nutrient cycling	Puts carbon back to soil and improves system productivity (crop yield and livestock productivity)	Education in consumption behavior helps consumers to change their diets
Contamination of soil and water	Use quality feeds	Culling mediocre ones releases feed for productive ones; reduces GHG emitted	
Human health concerns, pollution	Selective culling of unproductive animals, improved herd health		
Reducing land holding	Minimize involuntary culling		

(d) *Enhancing research into farming methods* to generate knowledge in search of better ways of managing farm inputs, characterizing local livestock breeds in terms of their resistance and tolerance to specific diseases, adaptation to poor-quality feeds or to feeding in harsh conditions, and tolerance to climatic extremes.

(e) *Improving policies* have the greatest chance of success in mitigation if they build on traditional pastoral institutions and knowledge, while providing pastoralists with food security benefits at the same time.

15.5 Enabling Conditions for Climate Change Adaptation

National politics and policies have a major effect on the livelihood of livestock keepers. Supportive policies stimulate, for example, the import of live animals in Jordan and Lebanon. Jordan relies on importing beef cattle for meat. Lebanon imports more than twice the amount of cattle and more than half the amount of sheep than that reared in the country. These import numbers are high, as local production is not supported by regulations and policies and witnessed that importing is cheaper than local production leading to further decline in local food production. The impact of climate change on the price of feeds will have direct effect on livestock production and import. In order to respond to the increasing demand for livestock products, enhancing local production should be stimulated by national policies. The import of live animals for local slaughtering ignores the GHG emission of livestock production elsewhere.

Gender disaggregation of roles in livestock production systems should be studied (Tibbo et al. 2008) to direct appropriate capacity building to improve adaptive responses to the impacts of climate change. Climate change is likely to intensify existing inequalities and have different effects on the capacity of women and of men to cope with additional stresses (IFAD 2009). In view of their role as the most significant suppliers of family labor and efficient managers of household food security, more emphasis needs to be placed on ensuring that any adaptation and mitigation strategies developed take into account these differences and the increased needs of women for building community resilience to climate change.

Regional cooperation needs enhancement in areas of the implementation of Global Plan of Action for Animal Genetic Resources (GPA-AnGR), developing regional capacity in vulnerability assessment, monitoring and adaptation measures, drought insurance scheme, early warning systems for climate risk reduction, regional trust fund for climate change adaptation and mitigation, mapping breeds against environment for exchange and conservation of genetic resources for sustainable use in the region, etc.

15.6 Conclusions and Recommendations

Climate change will have far-reaching effects on livestock sector in all the NENA countries although the impacts will vary considerably from location to location. Reduction in rainfall by up to 29 % and temperature increase by up to 4 °C will significantly reduce water available for much needed increase in food

production. Degradation of rangelands will negatively impact food and feed production and biodiversity conservation. Extreme climatic events will be evident such as droughts, floods, sea level rise, sand storms and occasionally snow. Better modeling of impacts is needed to better define (at local level) and assure investment in adaptation strategies. Increasing incidences of droughts, new animal diseases and parasites, and scarcity of feed supply are issues farmers have already experienced. Disappearance of palatable rangeland species following severe degradation of grazing lands, severe water shortage and shrinkage of annual rivers, repeated crop failures due to recurrent droughts are visible phenomena. Producers have been trying to adapt to these changes but with only short-term measures and need sustainable and coordinated adaptation and mitigation measures so that they continue to produce by increasing resilience of their production systems. It is recommended that:

(a) Climate change impact assessment on livestock sector and the use of model projections should be considered as a priority.
(b) Adaptation to climate change is a top priority for livestock, crops and rangelands among others to achieve food security.
(c) Adaptation and mitigation to climate change are very much linked in natural resources sectors, including biodiversity and genetic resources for food and agriculture, and therefore attention should be paid to both aspects in view of synergies and funding opportunities.
(d) Full regional cooperation and exchange of successful experiences among countries using various networks and fora, funding for regional projects and programs should be strengthened.
(e) Enhancing coordination among relevant institutions at the local, national and regional levels, including the understanding of how farmers and herders, are coping with climate change for improving sharing of best practices. Exchange of genetic resources for food and agriculture and of their related knowledge may also be taken into consideration.
(f) Financing adaptation actions should be ensured through rural development funding mechanisms (official development assistance and other sources) as a primary funding source, with complementary specific climate change funding mechanisms or integrating adaptation priorities into rural development programmes and funding mechanisms may be relevant.
(g) Member Countries of the Region, FAO and other organizations to launch a cooperative action in order to enhance national capacities in tackling the impacts of climate change on agriculture and food security in the Region through:

    - Enhancing involvement of policy and decision-makers and their recognition of climate change impacts;
    - Elaborating and implementing national policies and strategies for adaptation to climate change in agriculture and food security;
    - Considering the needs of proper management of genetic resources for food and agriculture in planning and implementing National Adaptation Programs of Action and Nationally Appropriate Mitigation Actions;

- Developing capacity in vulnerability assessment, monitoring and adaptation measures;
- Supporting assessment of the impact of climate change on livestock and rangelands in the region;
- Improving data-collection and information-sharing on climate change impacts and adaptation options between relevant stakeholders;
- Developing early warning systems against extreme climatic events;
- Strengthening national coordination among the multiple stakeholders and expanding involvement of stakeholders to include NGOs, civil society, universities, the private sector, etc.;
- Increasing public and private investment in climate change adaptation, improving capacity to access other available financial resources and considering the establishment of weather-based index insurance;
- Promoting the climate change agenda in the agricultural sector within national institutions systematically for fund raising;
- Enhancing integrated ecosystems approaches;
- Enhancing community-based management of livestock and rangeland resources;
- Implementing more flexible risk-management strategies through adjustments in stocking rates along with diversifying species of animals kept, and multiple production systems;
- Enhancing agricultural technologies such as the development of stress-tolerant forage varieties and the improvement of water resources development and management;
- Development partners assisting the assessment of climate change impacts should consider the formulation of projects aimed at improving the sustainable management of the scarce natural resources and safety nets and support projects to enhance the livelihoods of vulnerable groups.

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