Review on the Impact of Climate Change on Livestock Production and Genetic Diversity

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***Abstract* - A comprehensive review on the impact of climate change on livestock production and genetic diversity is reviewed. Biological diversity is vitally important for every sphere of human existence and provides us with a vast range of products and services. Biodiversity and climate change are closely linked and each impacts upon the other. Climate change will further exacerbate the effects of other stressors and is likely to become the dominant direct driver of biodiversity loss by the end of this century. There was acceleration in the loss of the genetic (crop & domestic animals) and cultural diversity already occurring in agriculture as a result of globalization. A 2.5° C rise in global temperature would determine major losses: between 20 and 30 per cent of all plant and animal species assessed could face a high risk of extinction. Globally, human population is expected to increase from around 6.5 billion today to 9.2 billion by 2050. A high genetic richness means a greater ability for some of the individuals to adapt to changes in the environment. Sixteen per cent of animal genetic resources (AnGR) have been lost over the last 100 years. One of the most evident and important effects of climate change on livestock production is mediated through changes in feed resources, water supply and diseases outbreak. For, Bos indicus water intake increases from about 3 kg per kg DM intake at 10 °C ambient temperature, to 5 kg at 30°C, and to about 10 kg at 35°C. Changes in temperature also compromise the quantity and quality of forage. Future utilization of AnGR in climate change adaptation, or for other purposes, requires that the relevant resources have not been lost.**

***Key words* - Climate Change, Livestock Production, Animal Genetic Resources (AnGR)**

1. Introduction

Climate change makes development more expensive, complicated, and uncertain than was thought. Climate has already changed in ways that impose costs-for instance by making rainfall more variable [30]. In most developing countries livestock is the key asset for rural people providing multiple economic, social and risk management functions [14]. Global climate change is the hottest environmental issue today. It is not new phenomena, but the warming that is occurring today is unprecedented with respect to the rate of change. According to the Intergovernmental Panel on Climate Change (Fourth Assessment Report: IPCC 2007), the term 'climate change' refers to 'a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period [19]. Future annual warming of the world is projected to increase in the coming decades. Agriculture is one of the most climate-sensitive industries, with outdoor production processes that depend on particular levels of temperature and precipitation [28]. Some of the worst effects of climate change on human health and agriculture will be in sub Saharan Africa, including impacts on livestock [29].

Climate change is likely to pose new challenges in the livestock production sector, especially among the poor resource farmers in sub-Saharan Africa. The opportunity provided by locally adapted livestock for the production of manure, meat, wool and milk, and the provision of work, transport and social functions in harsh environments represents an entitlement (endowment) of local people. Sixteen per cent of animal genetic resources (AnGR) have been lost over the last 100 years. One of the most evident and important effects of climate change on livestock production is mediated through changes in feed resources, water supply and diseases outbreak. Changes in temperature also compromise the quantity and quality of forage. It has been known that increased temperatures, increases lignifications of plant tissues and therefore reduces the digestibility and the rates of degradation [22]. The overall implications of climate change for the livestock sector and for AnGR diversity are not easy to predict. Therefore, this paper aims to give an overview on the impact of climate change on livestock production and genetic diversity.

2. Impact of Climate Change on Livestock Production and Genetic Diversity

Impact of Climate Change on Individual Animal

Heat stress is an important factor in determining specific production environments already today, impacting male and female reproduction and production and increasing mortality. Measurement of the effects of heat and other stressors is complex and difficult. Heat stress is an important factor in determining specific production environments already today [33]. The effect of heat stress on milk yield at specific test days is more immediate and easier to measure than on growth [32]. One of the most evident and important effects of climate change on livestock production is mediated through changes in feed resources, water supply and diseases outbreak. Although the direct effects of climate change on the animals are likely to be small as long as temperature increases do not exceed 3° C, climate change will affect animals directly through physiological stress and thermoregulatory

control, nutrition and disease stress. Adaptation to harsh environments includes not only heat tolerance but also to their ability to survive, grow and reproduce in the presence of poor seasonal nutrition as well as parasites and diseases [6, 8, 15 and 17].

Impact of Climate Change on Livestock Production

Livestock and climate change have a close relationship [18]. One of the most evident and important effects of climate change on livestock production is mediated through changes in feed resources, water supply and diseases outbreak. For, Bos indicus water intake increases from about 3 kg per kg DM intake at 10 °C ambient temperature, to 5 kg at 30°C, and to about 10 kg at 35°C. Some of the greatest impacts of global warming will be visible in grazing systems in arid and semi-arid areas [16]. Increasing temperatures and decreasing rainfall reduce yields of rangelands and contribute to their degradation. Higher temperatures tend to reduce animal feed intake and lower feed conversion rates [24]. There is also evidence that growing seasons may become shorter in many grazing lands, particularly in sub-Saharan Africa.

The spatial distribution and availability of pasture and water are highly dependent on the pattern and availability of rainfall [3]. Changes in the patterns of rainfall and ranges of temperature affect feed availability, grazing ranges, feed quality, weed, pest and disease incidence. Thus, changes in climatic factors such as temperature, precipitation and the frequency and severity of extreme events like droughts directly affected livestock productivity [1]. The harsh effect of climate change is expected to have maximum impact on vulnerable pastoral communities engaged in extensive livestock production systems in dry-lands [25].

Global warming is expected to further contribute to this degradation process and according to [27] large areas of the African continent will have a reduction of the length of the growing period of the vegetation by 20% in 2050. Besides, [26] reported that in some regions of Africa invasive species linked by pastoralists to both restrictions on bush burning and climate change are severely reducing or eliminating viable grazing areas. Trends indicative of climate change, such as increasingly recurrent drought, floods, erratic rainfall patterns, and high temperatures are adding significantly to these stresses.

Warming is also expected to alter the feed intake, mortality, growth, reproduction, maintenance, and production of animals [23]. As reported by [31] recurrent droughts, flash floods, diseases, and pests are among the prevalent disaster risks related to climate change in the lowlands of Sothern Ethiopia. Pastoral communities are the major victims of these disaster risks [3]. The effects of climate change on livestock production and health could be an additional significant burden to the already existing problems that hold back livestock development in Africa [5]. Livestock productivity is affected most severely under the Ethiopia dry scenario, in which the ratio between future and baseline productivity falls to a low value of approximately 0.70 in the moisture reliable humid lowland zone, or a 30 percent decline in productivity. Under each scenario, there is a downward trend in productivity over the 2001 to 2050 period [23].

When animals are genetically adapted to specific/extreme conditions, they will be more productive. To increase productivity, farmers have been advised to adapt their dairy genetics to the changed diverse production environments through; (a) Increasing gene flow and introduction of breeds more adapted to the environment; (b) breeding for improved adaptation to heat, disease and harsh conditions using tropically adapted breeds/genes or insert specific genes via strategic crossbreeding or biotechnology; and (c) use adaptive traits of indigenous animal genetic resources [27, 15 and 2].

Biodiversity and Climate change

Biodiversity and climate change are closely linked and each impacts upon the other. Climate change is likely to negatively impact on biodiversity in certain areas, since some habitats and ecosystems are likely to shift their borders [21]. Climate change will further exacerbate the effects of other stressors and is likely to become the dominant direct driver of biodiversity loss by the end of this century. There was acceleration in the loss of the genetic (crop & domestic animals) and cultural diversity already occurring in agriculture as a result of globalization. A 2.5° C rise in global temperature would determine major losses: between 20 and 30 per cent of all plant and animal species assessed could face a high risk of extinction [9]. Animal genetic diversity is critical for food security and rural development. It allows farmers to select stocks or develop new breeds in response to changing conditions, including climate change, new or resurgent disease threats, new knowledge of human nutritional requirements, and changing market conditions or changing societal needs – all of which are largely unpredictable. What is predictable is increased future human demand for food [7].

Globally, human population is expected to increase from around 6.5 billion today to 9.2 billion by 2050. Rapid urbanization and global demand for livestock products expected to continue in developing countries in the coming decades. In addition, the variability and changing of climate adds to the already considerable development challenges. A high genetic richness means a greater ability for some of the individuals to adapt to changes in the environment. The opportunity provided by locally adapted livestock for the production of manure, meat, wool and milk, and the provision of work, transport and social functions in harsh environments represents an entitlement (endowment) of local people. Sixteen per cent of animal genetic resources (AnGR) have been lost over the last 100 years. Directly or indirectly climate change has impacts of on AnGR such as catastrophic events, disease epidemics, productivity losses, physiological stress, water availability, agro-ecological changes (fodder quality and quality, host-pathogen interactions and GHG reduction) and resource price/availability (feed production) [17]

Climate change comes as an additional factor affecting a livestock sector that is already highly dynamic and facing many challenges. Important objectives of AnGR management include ensuring that AnGR are effectively deployed to meet these challenges (i.e. are well matched to the production environments in which they are kept) and that the genetic diversity needed to adapt production systems to future changes is maintained. All livestock production depends on access to the feed and water that animals need to survive, produce and reproduce [11]. Climate change is likely to create a number of problems in many areas of animal husbandry (housing, feeding, health care, etc.) and threaten the sustainability of many livestock production systems and their associated AnGR. At the same time, many of the specific challenges associated with climate change (high temperatures,

disruptions to feed supplies, disease outbreaks, etc,) as well as the general unpredictability it brings to the future of the livestock sector, highlight the importance of retaining diverse genetic options for the future [22].

Climate Change and Conservation of Livestock Diversity

The ratification of the Convention on Biological Diversity (CBD) in 1993 represents an international consensus to conserve biodiversity, including genetic diversity of livestock [21]. Future utilization of AnGR in climate change adaptation, or for other purposes, requires that the relevant resources have not been lost. Approximately 22 percent of breeds recorded in the Global Databank on Animal Genetic Resources are classified as being at risk of extinction and another 38 percent are of unknown risk status [12]. Numerous threats to AnGR diversity have been identified [13, 8 and 22]. As discussed in Section B, some of these threats are likely to be intensified by climate change. The Global Plan of Action for Animal Genetic Resources [9] recognizes the significance of climate change and the need for conservation programmes and strategies to account both for gradual environmental changes in livestock production systems and the effects of disasters and emergencies.

Conservation aims to maintain the option value of genetic diversity, it is therefore a priority of the Global Plan of Action for Animal Genetic Resources [9]. Conservation measures for threatened breeds have already been established in some countries [8]. Most current conservation programmes are based in developed countries with strong collaboration between gene banks and animal breeding organizations [8]. In developing countries, the focus is typically on in vivo conservation. Conservation usually involves the characterization of animal genetic resources and the subsequent development of inventories, including information on the spatial distribution of breeds and valuable breeding stocks, and priority setting [4 and 20).

3. Conclusions

From this review I conclude that livestock and climate change have a close relationship. That is directly or indirectly climate change has impacts of on AnGR and their production. One of the most evident and important effects of climate change on livestock production is mediated through changes in feed resources, water supply and diseases outbreak. Changes in temperature compromise the quantity and quality of forage by increase lignifications of plant tissues and reducing digestibility and rate of degradation. Besides, Climate change will further exacerbate the effects of other stressors and is likely to become the dominant direct driver of biodiversity loss by the end of this century. A high genetic richness means a greater ability for some of the individuals to adapt to changes in the environment. When animals are genetically adapted to specific/extreme conditions, they will be more productive. Therefore keeping livestock genetic diversity is the bases for improvement and conservation programmes as well as a strategy for gradual environmental changes in livestock production systems and the effects of disasters and emergencies for the future.

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