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THE IMPACT OF CLIMATE CHANGE ON LIVESTOCK PRODUCTION FEED RESOURCES AND ITS MITIGATION OPTIONS IN THE TROPICS: A REVIEW

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Abstract. Although livestock production in the tropics has been a major livelihood for household and pillar for the national economy, production and productivity of livestock has been highly hampered by the prevailing climate change and extensive production systems such as free grazing of livestock. Climate change is seen as a major risk to the survival of many species, ecosystems including sustainability of farm animals. It is evident that climate change has negative effect on animals causing heat stress, changes feed availability and quality, water availability and through emergence of diseases and disease carriers. Moreover, climate change may result in decrease in population of susceptible stock or lead to increase in population of less prone. Although, the effect of climate change on livestock production has been researched and reviewed by many researchers, there are only few studies showed the effect of livestock on climate change and mitigation options together in the tropical livestock. On the other side, free grazing which is a common feature of extensive production has been shown to affect the environment indirectly lead to climate change and affect production and productivity of animals. Optimum grazing practice and proper management of livestock and grazing lands can be a tool to maintain or enhance biodiversity of grazed areas. This paper reviews the two major obstacles of livestock production and highlights the mechanisms of adaptation techniques for better livestock production and environment in this part of the world. Policies in this area need to be continuously reviewed with respect to biological, environmental and economic impacts. Lastly, strategic research is required into methods of achieving compliance with environmental protection and sustainable agricultural practice in developing countries.

Keywords: *climate change, feeding, free crazing, livestock production tropics.*

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1. Background

The increasing trend of world human population (around 9 billion by at 2050) requires high food production including animal origin foods (Roberts, 2011; UN, 2014). This indicates that fast rising populations necessitate the existing food production to be boost by at least 50% by 2050 (Gill *et al*., 2010). The requirement of enormous quantity of food is the result of not only due to increment in population but also due to economic development which increases consumer purchasing power of livestock products (Horlings & Marsden, 2011). Moreover, the livestock sector also help in changing of human non-edible biomass (around 60%) and converting it to food (Krausmann *et al.*, 2008). Moreover, livestock are also associated with many critical outcome of environmental impacts, livestock reduces vulnerability to environmental risks for 600 million poor smallholder farmers (Steinfeld *et al*., 2006; Thornton & Herrero, 2010) and provides livelihoods as well as many other services beyond food production such as traction and nutrients (Herrero *et al*., 2009). Especially for many poor and undernourished people in the developing world, livestock products are crucial for protein supply. Concerning Gross Domestic Product (GDP) and employment of the world, the livestock segment accounts for 40% of the world's agriculture GDP and employ 1.3 billion people, and create livelihoods for one billion of the world's population living in poverty (FAO, 2006). In many rural communities, livestock is the only asset of the poor, but it is highly vulnerable to climate variability and extremes (Thornton *et al.,* 2007; IFAD, 2010). Livestock farming remains the backbone of most African economies (Hussein *et al.,* 2008). The impact of climate change is expected to heighten the vulnerability of livestock systems and reinforce existing factors that are affecting livestock production systems (Gill & Smith, 2008).

Grazing lands are important sources of livestock feed in developing countries, although unrestricted access to such resources can result in overexploitation and land degradation. Although grazing has such importance to the ecology and economy of grazers, casual free grazing system has contributed significantly to the land degradation problem in many parts of the world. The free grazing system has a negative effect on the conservation efforts, as trampling animals often damage physical conservation structures such as stone terraces and soil bunds. Thus, the free grazing system results in significant negative externalities, especially for farmers who do not own livestock, as they are forced to bear the additional cost of maintaining their plots.

2. Impact of climate change on livestock feed quantity

The potential impacts on livestock include changes in production and quality of feed crop and forage (IFAD, 2010; Polley *et al*., 2013), water availability (Nardone *et al*., 2010), yield (Henry *et al*., 2012), disease occurrence (Nardone *et al*., 2010; Thornton *et al*., 2009), reproduction, and biodiversity (Reynolds *et al.,* 2010). These impacts are primarily due to an increase in temperature and atmospheric carbon dioxide (CO2) concentration, precipitation variation, and a combination of these factors (Henry *et al*., 2012). Temperature affects most of the critical factors for livestock production, such as water availability, animal production, reproduction and health. Forage quantity and quality are affected by a combination of increases in temperature, CO2 and precipitation variation. Livestock diseases are mainly affected by an increase in temperature and precipitation variation.

Global warming is likely to favour C4 plants through its impact on increasing minimum daily temperature of a region, increasing photorespiration and reducing quantum yield in C3 plants (Polley *et al.,* 2000). C4 species (which account for less than 1% of plants on Earth) are found in warm environments, and have higher water-use efficiency than C3 plants. Temperature increases to 30–35 °C could increase herbage growth, with larger effects on C4 species. However, the effects may vary depending on the location; production system used, and plant species (IFAD, 2010; Thornton & Herrero, 2010). The changes in temperature and CO_2 levels will affect the composition of pastures by altering the species competition dynamics due to changes in optimal growth rates (IFAD, 2010; Thornton *et al*., 2015).

Regarding to the quality of feed, quality of feed crops and forage may be affected by increased temperatures and dry conditions due to variations in concentrations of water-soluble carbohydrates and nitrogen. Temperature increases may increase lignin and cell wall components in plants (Polley *et al*., 2013), which reduce digestibility and degradation rates (IFAD, 2010; Polley *et al*., 2013), leading to a decrease in nutrient availability for livestock (Thornton *et al.*, 2009). However, as CO_2 concentration rises forage quality will improve more in C3 plants than C4 plants. C3 plants also have greater crude protein content and digestibility than C4 plants (Thornton *et al.*, 2009; Polley *et al.*, 2013). Impacts on forage quantity and quality depend on the region and length of growing season (Polley *et al.*, 2013). An increase of 2°C will produce negative impacts on pasture and livestock production in arid and semiarid regions and positive impacts in humid temperate regions. The length of growing season is also an important factor for forage quality and quantity because it determines the duration and periods of available forage. A decrease in forage quality can increase methane emissions per unit of gross energy consumed (Benchaar *et al.*, 2001). Therefore, if forage quality declines, it may need to be offset by decreasing forage intake and replacing it with grain to prevent elevated methane emissions by livestock (Polley *et al.*, 2013).

Livestock have several nutrient requirements including energy, protein, minerals, and vitamins, which are dependent on the region and type of animal (Thornton *et al.*, 2009). Failure to meet the dietary needs of cattle during heat stress affects metabolic and digestive functions (Mader, 2003). Thermal livestock stress decreases feed intake (Thornton *et al.*, 2009) and efficiency of feed conversion, especially for livestock that are fed large amounts of high quality feeds (Haun, 1997).

3. Effect of climate change on water availability

Population growth, economic development and climate change impacts will undoubtedly have a substantial effect on global water availability in the future. The response of increased temperatures on water demand by livestock is well-known. For Bosindicus, for example, 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 (NRC, 1981). The impacts of climate change on water supply changes in livestock systems, however, are not well-studied. The key contribution of groundwater to extensive grazing systems will probably become even more important in the future in the face of climate change, although the impacts on recharge rates of the aquifers involved are essentially unknown (Masike, 2007). The coming decades are likely to see increasing demand and competition for water in many places, and policies that can address allocation and efficiency issues will increasingly be needed.

Global agriculture uses 70% of fresh water resources, making it the world's largest consumer (Thornton *et al.*, 2009). However, global water demand is moving towards increased competition due to water scarcity and depletion, where 64% of the world's population may live under water-stressful conditions by 2025 (Rosegrant *et al.*, 2002). The availability of water availability issues will influence the livestock sector, which uses water for animal drinking, feed crops, and product processes (Thornton *et al.*, 2009). The livestock sector accounts for about 8% of global human water use and an increase in temperature may increase animal water consumption by a factor of two to three (Nardone *et al.*, 2010). To address this issue, there is a need to produce crops and raise animals in livestock systems that demand less water (Nardone *et al.*, 2010) or in locations with water abundance.

As sea level rises, more saltwater will be introduced into coastal freshwater aquifers that contributes to chemical and biological contaminants and high concentrations of heavy metals already found in water bodies and may influence livestock production (Nardone *et al*., 2010). Water salination could affect animal metabolism, fertility, digestion and then chemical contaminants and heavy metals could impair cardiovascular, excretory, skeletal, nervous and respiratory systems, and impair hygienic quality of production.

4. Effect of climate change on plant species dynamics and diversity

Much of the world's grasslands are characterized by swards that are botanically diverse. In a field experiment at varying levels of plant species diversity, the enhanced biomass accumulation in response to elevated levels of CO2 was greater in species-rich than in species-poor assemblages (Reich *et al*., 2001). In some studies grassland communities have grown in elevated CO2 displayed higher plant species diversity than controls under ambient. Moreover, high nitrogen use efficiency would confer a competitive advantage under elevated CO2 to mixed grasses. Such experiments show that the diversity and botanical composition of temperate grasslands is likely to be affected by the current rise in the atmospheric CO2 concentration, and that grassland management guidelines will need to be adapted to a future high CO2 world.

Species composition change is also an important mechanism altering production and its value for grazing livestock in drier rangelands with woody shrub invasion and in warm humid climates with C4 invasion. Woody plant proliferation in grasslands and savannas in recent history has been widely reported around the world. The causes for this shift in vegetation are controversial and center on changes in livestock grazing, fire, climate, and atmospheric CO2 (Hibbard *et al*., 2001). Increased CO2 levels is predicted to increase C3 plants over C4 but the projected increase in temperature will favor the C4 plants. Results from White et al. (2001) indicate that competition is highly important in limiting the invasion of C3 grasslands by C4 species. According to Lüscher et al. (2005), C4 species tend to be favoured over C3 species in warm humid climates, the reverse being so in cool climates. Global warming is likely to favour C4 plants through its impact on increasing minimum daily temperature of a region, increasing photorespiration and reducing quantum yield in C3 plants (Polley *et al*., 2000).

5. Effect of climate change on forage quality

Animal requirements for crude proteins from pasture range from 7 to 8% for animals at maintenance up to 24 % for the highest producing dairy cows. In conditions of very low N status the reduction in crude proteins under elevated CO2 may put a system into a sub-maintenance level for animal performance. C4 grasses are a less nutritious food resource than C3 grasses both in terms of reduced protein content and increased C/N ratios. Elevated carbon dioxide levels will likely alter food quality to grazers both in terms of fine-scale (protein content, C/N ratio) and coarse-scale (C3 versus C4) changes. However, when legume development is not restricted by adverse factors (such as low phosphorus and low soil water), an increase in the legume content of swards may compensate for the decline in the protein content of the non-fixing plant species (Allard *et al*., 2003, Picon-Cochard *et al*., 2004).

Effects of overgrazing on vegetation

Botanical composition of the pasture is influenced by the joint effect of several environmental factors. In an experiment, Jones and Bunch (1995) found that the spread of a specific plant species was more affected by the annual precipitation than by the presence of animals. Grazing animals also have an effect on the botanical composition by trampling and selective grazing. Furthermore, animal faeces and urine change the element content of soil and plants. Species composition is also influenced by the time of the year that a pasture is grazed. Hyder *et al.* (1975) pointed out that repeated heavy grazing during any particular month in the growing season had approximately three times higher effect on key species as did grazing during the months when plants were senescent.

The way that a plant community responds to a specific grazing pressure depends on the season effect. Moreover, high grazing pressure decreases plant density. However, this may not decrease the total plant production of a given community, because the roots of other plants may simply occupy that space in the soil. These other plant species are often less productive and less palatable, often weedy forbs and brush, which would result in decreased animal productivity (PAI, 2004). According to Pratt (2002), it is important to notice that weeds do not make the land unhealthy; they appear because the land is unhealthy. High grazing pressure changes the botanical composition of the pasture.

Brizuela and Cid (1993) stated that the first signs of overgrazing were a decrease in legumes and an increase in forbs and in bare soil. Similarly to overgrazing, the lack of grazing also has negative impacts on pastures of continental climate, for instance it entails the spread of weed and shrub species. In an experiment of Longhi *et al*. (1999) species number was higher within ungrazed, fenced areas or areas where topography provided protection from grazing. Moreover, species number was correlated with herbage height, which is an indicator of grazing intensity. On the other hand, Paulsamy *et al*. (1987) found that both protected and grazed sites had equal numbers of species with different floristic composition. Intense grazing destroyed a few palatable annuals and overgrazing favored the invasion of certain unpalatable annuals such as Amaranthusspinosus. If these species remain unchecked, they could be dominant in due course and alter the pasture value of the grassland. Fuls (1992) claimed that long-term patch-overgrazing induced substantial vegetation retrogression with reductions in basal cover up to 90%.

Livestock overgrazing is considered as the main cause of rangeland degradation through lowering both the productivity and resilience of host species, reduction of vegetation cover, increase of unpalatable species, decrease of species diversity, and alteration of soil structure and compactness (Kairis *et al*., 2015). Effects of grazing on the plant community and soils are viewed as destructive agents because of the reduction of ground cover, productivity and soil erosion (Al-Rowaily *et al*., 2012). Heavy grazing pressure has been reported to reduce the diversity of herbs and shrubs in the range land (Zhao *et al*., 2006). Heavy grazing pressure has been reported to reduce the diversity of herbs and shrubs in the range land (Zhao *et al*., 2006). Due to overgrazing, the vegetation species composition, richness and productivity has changed over the past decades, some species have disappeared, while others have survived through the use of morphological or other adaptations (Wang *et al.*, 2002).

Effects of overgrazing on soil properties

Increased livestock numbers in arid regions cause overgrazing which results in reduced infiltration and accelerated runoff and soil erosion. Results of several studies indicate that at the macro- and mesoscales soil erosion can increase dramatically due to overgrazing, causing increases of 5 to 41 times over the control at the meso-scale and 3 to 18 times at the macroscale (Sharma, 1997). Villamil *et al*. (1997) pointed out those inappropriate cattle grazing practices, such as overgrazing harm the quality of natural pastures and soil properties. The soil structural degradation in the upper horizons are approved by high bulk density values, high dry mechanical resistance and low structural stability in comparison with the climax situation.

Zhang *et al.* (2001) stated that heavy grazing can cause grassland deterioration because of heavy defoliation and treading, and is often used for weed control. Jiang *et al.* (1996) also found that sheep nigh penning combined with grazing has eliminated the natural vegetation containing shrubs. The removal of natural vegetation is caused by the fact that the concentrations of ammonium-N and nitrate-N in the soil were high enough to be toxic to plant roots during and after sheep night penning (Zhang *et al*., 2001). Evans (1996) observed that degradation occurred mostly along fences where often more than half the soil was exposed to trampling and weathering. Similarly, Moles (1992) described that bare soil is commonly found along tracks, for example around gateways or farm buildings where animals concentrate. Most bare soil, sometimes referred to as ‘sheet erosion’ (Whitlow, 1988) is created by sheep at small breaks of slope where they initiate scars by rubbing against the vegetation (Evans, 1977). Scars have been extended by the constant disruption of the soil surface by hooves, being used not only as scratching posts but also for shelter, so that vegetation cannot colonize and stabilize the surface (Evans, 1977).

Overgrazing is believed to be the most important cause of soil degradation worldwide (Oldemann *et al*., 1991), sharing about 35.8% of all forms of land degradation. However, degradation caused by overgrazing is especially widespread in Australia and Africa, where it accounts for 80.6% and 49.2% respectively of all soil degradation, and least extensive in Europe (22.7%) (Warren & Khogali, 1992). Wilson and MacLoad (1991) include animal performance as well; they state that grassland is overgrazed where concomitant vegetation change and loss of animal productivity arises from herbivores’ grazing of land. An optimum stocking rate allows grazing animals to produce at the most economical rate (Cowlishaw, 1969). The fact that overgrazing is not a function of animal numbers, but rather a function of time, has to be emphasized. Overgrazing occurs when animals are kept in a paddock too long or brought back too soon, the latter means that a plant is grazed before it has recovered from a previous grazing (Pratt, 2002).

Plant communities are disturbed when animals graze them. Farm animals can make easy the establishment of invasive plants by trampling and defoliating established species, thereby reducing their competitive ability and creating bare patches, and by disrupting nutrient cycles (Dorrough *et al.*, 2004). However, grazing removal also represents a disturbance (Hayes & Holl, 2003). Moderate grazing has been shown to promote community diversity (Fujita *et al*., 2009), and livestock exclusion can result in diversity loss by allowing certain species out-compete other species and establish dominance (Schultz *et al*., 2011). Livestock grazing can have a profound effect on vegetation and the general pattern of grazing induced vegetation change is well documented (Illius & O’Connor, 1999). It is known that undesirable species is increasing at the expense of desirable species.

6. Impacts of overgrazing on plant succession

Grazers and browsers affect the productivity, composition and the stability of plant communities through their influence on germination, establishment and plant mortality. With respect to plant succession, plants have been classified as either decreasers, increasers or invaders depending on their response to grazing (Dyksterhuis, 1949). Degreaser plant communities are those plants that make up a large proportion of the community but become reduced as the result of grazing. Those plants that increase in population, either because of their greater tolerance to defoliation or because they are less used by herbivores than other plants are known as increasers. If grazing pressure and stocking rate is maintained, any bare patches formed could be occupied by herbaceous annuals, unpalatable perennials or shrubs that were previously absent or limited in number and these plants are known as invaders. Invader plants are undesirable for livestock feed as they displace more acceptable or palatable species; invaders are also poor in nutritive value and have seasonal production patterns. The common problem of overgrazed lands by livestock is that invaders proudly succeed (Allan & Holst, 1996).

7. Balancing between Climate Change, Free Grazing and livestock production Production of climate smart feed resources

The production of climate smart grasses like *Pennisetum pedicellatum* is a C4 plant such as maize, sorghum, and sugarcane, approximately have 50% higher photosynthesis efficiency than those of C3 plants such as rice, wheat, and potato (Kajala *et al.*, 2011). C4 plants are often called tropical or warm season plants and more efficient at gathering carbon dioxide and utilizing nitrogen from the atmosphere and in the soil. According to Lüscher et al. (2005), C4 species tend to be favoured over C3 species in warm humid climates, the reverse being so in cool climates. Global warming is likely to favour C4 plants through its impact on increasing minimum daily temperature of a region, increasing photorespiration and reducing quantum yield in C3 plants (Polley *et al*., 2000). However, elevated CO2 levels may provide a partial offset, favouring C3 grasses (Polley *et al*., 1993) as well as broadleaved species (Byrne & Jones, 2002). They also use less water to make dry matter. C4 plants grow best at 90-95○F. They begin to grow when the soil temperature is 60-65○F. However, forage of C4 species is generally lower in protein than C3 plants but the protein is more efficiently used by animals. The C4 photosynthetic pathway requires much less Rubisco, so consequently and importantly, less leaf nitrogen (N) per unit leaf area for rapid photosynthesis (Sage *et al*., 1987). These adaptations allow C4 grasses to use water and nitrogen efficiently to achieve very high growth rates, provided temperatures are very crucial for climate change adaptation in tropical countries. Moreover, C4 plants are more efficient at gathering carbon dioxide and utilizing nitrogen from the atmosphere and in the soil. They also use less water to make dry matter. However forage of C4 species is generally lower in protein than C3 plants but the protein is more efficiently used by animals which are the characteristics of *desho* grass (Asmare *et al.*, 2016). *Desho* grass can be combined with other fodders fodder legumes either in mixtures or in rotation (with legumes) cropping (Skerman *et al*., 1990; Schmelzer, 1996).

8. Livestock feeding management systems

Climatic conditions determine the energy and nutrient metabolism of farm animals. According to relevant data climate change leads to a higher mean ambient temperature, and it may even result in extreme weather. This calls searching for feeding strategies in response to climate change, including nutritional manipulation and feeding during cold and heat stress. One of the most evident and important effects of climate change on livestock production is mediated through changes in feed resources. Although indirect, effects on feed resources can have a significant impact on livestock productivity, the carrying capacity of rangelands, the buffering ability of ecosystems and their sustainability, prices of stovers and grains, trade in feeds, changes in feeding options, greenhouse gas emissions, and grazing management. Animals consume more feed at low ambient temperatures in order to compensate for the increased energy requirement used in thermoregulation.

From the aspect of energy requirements a cold environment is essentially the equivalent of reduced energy supply, and thus higher feed intakes and higher energy intakes can meet the extra demand of thermogenesis. When the increased feed intake is prevented by the limitations of the animal's gastro-intestinal system, any means of boosting the dietary energy of the feed may be suitable for maintaining growth, and egg and milk production. Since heat production after ingestion of the diet is high, farm animals reduce their feeding activity at high ambient temperatures, which bears significant consequences on their nutrient intake. The practice of feeding the daily ration in several smaller portions or during the cooler parts of the day follows from the above. Based on the previous sections other potential feeding strategies can be applied at the time of heat stress, which (i) reduce the heat production by the animals; (ii) compensate for the lower nutrient supply; and (iii) alleviate heat stress induced metabolic changes. It should be noted, however, that during severe heat stress these methods should be used in combination in order to maintain the production performance of the farm animals and the quality of their products. Providing supplements, such as feed antibiotics, which tend to increase weight gain and reduce feed intake per metric ton of meat produced, can reduce enteric fermentation (Boadi *et al*., 2004). In the case of milk, bovine somatotropin (a bovine growth hormone) increases production. An increase in milk production leads to less animals needed to produce the same amount of milk and less emissions produced (EPA, 2013). Antimethanogen vaccines are another practice that directly reduces methane emissions in the rumen. However, this is a new technology with limited research on emission reduction efficiency and animal health (EPA, 2013).

Improving feeding practices as an adaptation measure could indirectly improve the efficiency of livestock production (Havlík *et al*., 2013). Some of the suggested feeding practices include, modification of diets composition, changing feeding time and/or frequency (Renaudeau *et al*., 2012), incorporating agroforestry species in the animal diet, and training producers in production and conservation of feed for different agro-ecological zones (IFAD, 2010). These practices can reduce the risk from climate change by promoting higher intake or compensating low feed consumption, reducing excessive heat load (Renaudeau *et al*., 2012), and reducing animal malnutrition and mortality (IFAD, 2010), respectively. Another adaptive measure could be adjusting crop rotations and changing timing of management operations (e.g. grazing, planting, spraying, irrigating). This measure can be adapted to changes in duration of growing seasons, heat waves and precipitation variability (IFAD, 2010).

9. Use of adaptive livestock breeds

The greatest role for using adaptive traits of indigenous animal genetic resources will be in more marginal systems in which climatic and other shocks are more common. Indigenous breeds, which have co-evolved in these systems over millennia and have adapted to the prevalent climatic and disease environments, will be essential (Baker & Rege, 1994). These systems are under substantial pressure arising from the need for increased production as well as land-use changes. Under these circumstances, ensuring continuing availability of these adapted animal breeds to meet the needs of an uncertain future is crucial. The adaptive challenge will be to improve productivity traits while maintaining adaptive traits. This co-evolution will take place at different speeds within different systems. Within this context, there will be a constant need to improve productivity since increasing demand will need to be supplied from a relatively non-increasing land and water resource base. Current animal breeding systems are not sufficient to meet this need and the improvement of breeding programs under different livestock production and marketing contexts is a critical area for new research.

10. Improving water access for livestock

Development of water resources has a significant impact on the livelihood of farmers through improving the productivity of animals. Water availability for livestock is relatively critical in the lowlands. According to McCornick et al. (2003), water availability can be improved through a number of ways such as construction of wells, pumps, canals, boreholes, tanks, cisterns, reservoirs, water yards, dams and water-harvesting structures. While selecting any given method, there is a need to consider the production system and socioeconomic situation of the farmers. The rehabilitation of water sources is usually a challenge in most cases.

Practice Zero grazing for herbivores

Forage refers to un-harvested plant materials (grasses, legumes or shrubs) that are available for livestock consumption. Forage can be established or improved with seed or vegetative materials and good management practices. With use of forage, farmers are better able to control their animals' diets and ensure that they have necessary nutrition for dairy production or weight gain.

Zero grazing is a grazing system that prevents livestock from grazing freely in open pasture. In this system, livestock is confined to a stall and fed with cut and carried fodder (harvested forage plant material) and other types of feed (concentrate, wheat bran etc.). Zero grazing systems help address issues of lack and degradation of grazing land, low productivity of dairy cows, low quality fodder and disease spread between free grazing cattle. It is also the ideal way to maintain improved breeds.

Land rehabilitation

Interventions focusing on improving water and soil conversation techniques and reforestation must be implemented on a large scale to revitalize degraded lands. Abatu *et.al*. (2009) state "with the current condition of the communal grazing lands; the sustainable utilization of the rangeland ecosystems is not possible. Practices like reforestation, soil conservation and water management are also crucial to sustain existing agricultural land. Biological conservation practices such a grass strips and tree plantations are important options for land rehabilitation practices. Avoiding effects of destroying the conservation practices through trampling are very crucial for sustainable ecosystem rehabilitation program.

Grazing Management

Grazing drastically alters plant species composition, particularly in mesic grasslands, and it also affects above-ground net primary production (Oesterheld *et al*., 1999). The degradation of the landscape may be a short-term phenomenon and recovery is possible after grazing pressures have been greatly reduced. This phenomenon can also be found in cold climates where, for example, reindeer have been introduced and thrived until their preferred forage has become grazed out (Leader & Williams, 1988). BCMF (2002) categorized the tools for managing overutilized grasslands. Several studies were carried out about bio-indicators of overgrazing. Read (2002) suggests reptiles as bio-indicators of the initial effects of heavy cattle grazing in a South Australian chenopod shrub-land.

11. Conclusion

Livestock keepers could be made more aware of climate change and variability so surveillance systems should be established or improved and capacity of the production system to deal with such changes should be enhanced. The development and establishment of coping strategies is a continuous process and need to be improved. However, this remains a big challenge and need to be well addressed to all stakeholders for their valuable contribution. Indeed a better understanding of the effect of climate change on animal health and production is crucial and good for recommendations on how to lessen its potential impact. Free grazing is a natural process of forage utilization, because herbivores produce in the environment where evolution formed them. This is the most appropriate, low cost tool for meat production. However, over grazing or uncontrolled has detrimental effects on soil and vegetation but changes are reversible. High grazing pressure decreases plant density, changes botanical composition, and often accelerates the invasion of unpalatable species. Moreover, overgrazing increases area covered by no vegetation, reduces infiltration, soil moisture and fertility, accelerates runoff and soil erosion, increases soil bulk density, penetration resistance, soil ammonia and nitrate content and changes soil microbial activity. Nevertheless, effects of climate change and free grazing problems are not irreversible problems of livestock production as they can be reduced via proper management of animals and resources on spot as indicated in this review paper.

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Conflict of interest

The author declares that there is no conflict in publishing of this paper.

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