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Mobile-livestock Keeping and Climate Change Challenges in Africa

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ABSTRACT

Livestock farming is one of the most important sub-sectors of the agricultural economy of developing nations. In Africa, Mobile-Livestock Keeping (MLK) or pastoralism is crucial to generating livelihoods and food security for some large population of the people particularly in the arid part of the continent. With rapid urbanization coupled with the population growth rate, the demand for livestock products far outstrips supply. This scenario if not checked may imply more expensive food that may not be economically feasible. Climate change, however adds to this national challenge facing MLK. It impacts on livestock production systems and in turn livestock farming impacts on climate change. This study tends to review the complex interaction between MLK and climate change and proposes some strategies that could pave the way forward and help sustain MLK as a key feature of most rural livelihoods in Africa.

Key words: Mobile-livestock keeping, greenhouse gases, climate change, livelihoods, food security, pastoralism

MOBILE-LIVESTOCK KEEPING-CRUCIAL TO NATIONAL AND REGIONAL ECONOMIC DEVELOPMENTS

Livestock farming is one of the most important sub-sectors of the agricultural economy. Globally, the sector contributes 40% of the value of agricultural output and employs approximately 1.1 billion people (Hurst *et al.*, 2005; Reynolds *et al.*, 2010). In Africa, Mobile-Livestock Keeping (MLK) is generating livelihoods and provide food security for some large population of people. Across Africa, an estimated 50 million livestock producers support their families, their communities and a massive meat, skins and hides industry based on animals that are fed solely on natural pastures (Hesse, 2010). Drylands make up 43% of Africa's inhabited surface and are home to 268 million people; 40% of the continent's population (De Jode, 2009). An estimated 50 million pastoralist and up to 200 million agro-pastoralists live and manage complex webs of profitable cross-border trade and draw huge economic benefits from rangeland ill-suited to other land use systems (De Jode, 2009). Thus, where other land-use systems are threatened in the face of global climate change, MLK is generating huge, national and regional economic benefits (Hesse, 2010).

In a sample of 14 countries, Steinfeld *et al.* (2006) reported that 60% of all rural households in developing countries keep livestock. Given this scenario, the poorest households were more likely to hold livestock than the wealthier ones, though the average number of animals kept was small; they made a sizeable contribution to livelihood (Reynolds *et al.*, 2010).

It is commonly believed that pastoralist move in response to pasture shortage. As a general rule pastoralists are much more concerned with the quality of the diet as measured by their animal's health and productivity (De Jode, 2009). Population growth and rapid urbanization coupled with rising urban incomes are fuelling an escalating demand for meat and fresh dairy products in this region. This demand is totally met by pastoralist (De Jode, 2009; Banerjee *et al.*, 2009). In Africa, livestock productivity faces multiple risks associated with land degradation, water scarcity, pollution and resource allocation on marginal lands. However, of the environmental problems, climate change exacerbates these concerns. How will MLK impact on climate change and how will climate change impacts on MLK are issues staring us in the face. What challenges this will bring in Africa and lessons to be drawn are key features in providing the way forward for rural livelihoods in the continent.

MOBILE-LIVESTOCK KEEPING'S IMPACT ON CLIMATE CHANGE

Carbon dioxide and other greenhouse gases trap heat in the atmosphere and raise average global surface temperatures. Emissions of carbon and other gases grew 12-fold between 1900 and 2000, from 534 million metric tons per year in 1900 to 6.59 billion metric tons in 1997 (Marland *et al.*, 2000) (Fig. 1).

Agriculture, especially animal husbandry causes considerable greenhouse gas emission (GHGE). Globally, livestock keeping account for about 9% of total anthropogenic GHGE (Smith *et al.*, 2007; Reynolds *et al.*, 2010). This rises to 18% (Steinfeld *et al.*, 2006) when all units (animal waste, transport, energy etc.,) of the livestock production systems are included (Fig. 2), they jointly account for almost 80% of all agricultural emissions (Reynolds *et al.*, 2010).

Within the livestock industry, dairy production and mobile-livestock systems are the largest sources of GHGE (Weiske *et al.*, 2006). Within this system, feeding was found to have a high impact on GHGE and exerts a significant effect from enteric fermentation and from manure (Hortenhuber *et al.*, 2011). Direct emissions from the feed supply-chain account for about 20% of GHGE per dairy cow per year. Therefore, total GHGE attributed to feeding are actually higher than stated above. Reynolds *et al.* (2010) reported that the main greenhouse gas (GHG) sources include methane (CH_4) emissions from enteric fermentation (1.8 billion tons CO_2 per annum), CH_4 and nitrous oxide (N_2O) from ruminant waste (1.5 billion tons per annum) including waste from the numerous abattoirs (Orji *et al.*, 2011). Additionally, GHGE from land use, Land Use Change

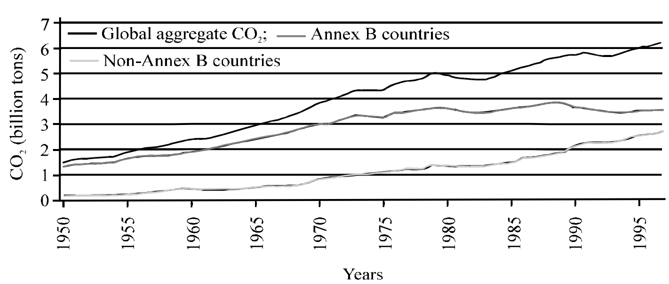

Fig. 1: The global CO_2 emissions, 1950-1997 (Source: Meyerson, 2002)

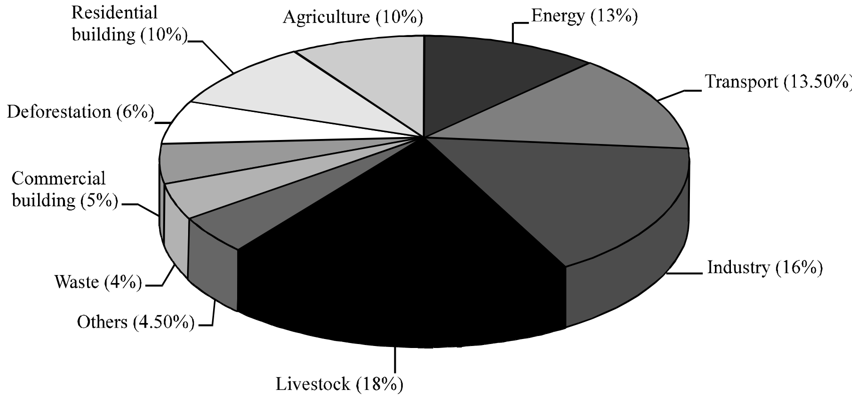

Fig. 2: The relative contribution of livestock system to global anthropogenic GHGE's (Source: Steinfeld *et al.*, 2006; adapted from Reynolds *et al.*, 2010)

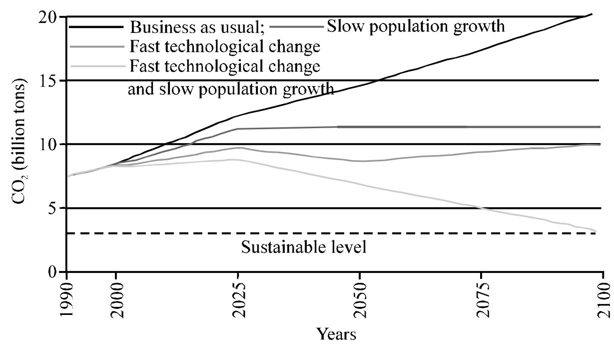

Fig. 3: Projected CO_2 emissions under different population and technology assumptions, 1990-2100, This figure expresses CO_2 emissions as elemental carbon, 1 ton elemental carbon = 33,664 tons CO_2 (Source: Harrison *et al.*, 2000)

(LUC) along with deforestation due to grazing and over-grazing are sources of substantial indirect GHGE connected with MLK and feeding. These global figures hide a dichotomy in emissions between developed and developing nations (Reynolds *et al.*, 2010) and within developing countries, a dichotomy between the most efficient (often large, industrial scale) farms and smallholder farms. However, these estimates of the GHGE's are subject to widespread debate amongst the scientific community given the complex nature of the problem (Herrero *et al.*, 2008). Despite the debate, it is certain that GHGE under different population and technology assumption as well as MLK particularly in Africa is on the rise (Fig. 3). In this region, LUC from grasslands, savannahs and tropical forest used for MLK as well as LUC for the production of some food/feedstuffs are all connected with a great loss of carbon (CO_2) in the soil with negative effects on the physicochemical properties of most soils (Eggleston *et al.*, 2006; Nigussie and Kissi, 2011). However, LUC was not always considered in previous estimation of carbon footprints (Garnett, 2009) but is now considered to play a central role for GHGE which are related to the use of pasture/feedstuffs. LUC contributes up to 1/5 to anthropogenic GHGE, especially where extensive forest clearing/grazing occurs in forested zones and over-grazing in fragile drylands common in Africa. Also, transports over long distances as seen in MLK consume high amounts of energy, contribute to GHGE from fossil fuels and render nutrient flows over great distances which counteract attempts to maintain fairly closed nutrient cycles.

Livestock systems influence the carbon balance of land as rainforest, forest, savannah and drylands are being cleared and ploughed to make way for arable crop/pasture-based systems (Steinfeld *et al*., 2006). The latter result in high CO_2 emissions from the burning of huge amounts of organic carbon stocks by mineralization in agricultural soils (Fehrenbach *et al*., 2008; Nigussie and Kissi, 2011). In Africa, arable farming is one of the biggest challenges to MLK and mobility. The slow but inexorable advance of family farms, combined in places with the establishment of large-scale commercial farming, is swallowing up vast areas of grazing lands which results in high rates of GHGE's in the region.

Ruminants, including donkeys, camels and horses used in MLK contribute to methane emissions as they are not efficient users of dietary nitrogen (Reynolds *et al*., 2010). Non-ruminants use food nutrients more efficiently but are also more likely to compete directly with humans for most feedstuffs. Ruminant systems tend to be more efficient especially when unconventional feeds/feedstuffs are considered (Khampa *et al*., 2009a, b; Nwaigwe *et al*., 2011). However, to achieve high productivity, substantial amounts of concentrates need to be fed, coupled with the LUC associated with concentrate production will spew high rates of GHG (Knaus, 2009). Production systems like MLK in Africa have adapted over a long period of time. These strategies on the best use of water and grazing have evolved over years and are known to be highly efficient and adaptive to suit local conditions, provide livelihoods and is extremely important for food security (De Jode, 2009; Averti and Dominique, 2011). Unfortunately, climate change threatens to alter the environment at a much faster rate than many of these systems can accommodate despite the prolong period of adaptation (Begum *et al*., 2011). This scenario according to Reynolds *et al*. (2010) highlights the need for long-term system-based assessments to account for total GHGE's attributable to livestock agriculture as a whole and MLK in Africa. Impact under MLK which is the predominant system in Africa is important as such analyses would help to identify routes to reduce GHGEs from livestock systems in the developing world.

CLIMATE CHANGE IMPACTS ON MOBILE-LIVESTOCK KEEPING

Effects of climate change on MLK system in Africa include impacts on land degradation forage yields, quality and availability, deforestation, water resource use, biodiversity depletion, thermal stress and related welfare issues, plus disease spread and control (Mia *et al*., 2012). Though most of these impacts are due to resource mismanagement, it is indeed certain that climate change potentially amplifies the consequences. These factors may in turn influence GHGE and the effectiveness of mitigation practices that may be adopted.

The impact of climate change on pastoral economy and fragile dryland ecology in Africa is rather dramatic (Elias and Abdi, 2010). Soil degradation is a major concern in Africa, where 300 million hectares have been affected, including 65% of agricultural land. Crop and pasture yields could be cut in half in 40 years if degradation continues at the current rate (UNFPA, 2001). In Southern Africa, over-grazing is a major contributor to soil degradation while large portions of Northern Africa are faced with desertification caused by a combination of over-grazing, rainfall variability and drought conditions occasioned by climate change.

Although Africa still accounts for 17% of global forest cover, forest are being steadily degraded by population growth, drought, agricultural expansion, fuel wood extraction, commercial timber exploitation, bush fires and welfare issues such as civil wars and political instability. During 1990-1995, Africa lost its forest cover at an annual rate of 0.7% (UNFPA, 2001).). This impact negatively on MLK. With rainfall variability, drought conditions coupled with persistent bush fires, mobility becomes very crucial. Moving is now becoming increasingly difficult and the economic profitability of MLK is being critically undermined. With poor nutrition, animals will produce less meat, milk and are more susceptible to drought and disease. As a result, livelihoods are affected, farmers become very vulnerable to conflicts even where it should have been avoided. Unsustainable agricultural practices such as shifting cultivation and slash-and-burn techniques in Africa contributes to the spate of deforestation, as commercial logging, oil exploration and mining activities.

While Africa uses only about 4% of its renewable fresh water resources and some countries have abundant lakes and rivers, countries in drylands depend on limited ground water reserves. Already, 14 countries in Africa are facing water stress. By 2025, another 11 countries are expected to face the same conditions (UNFPA, 2001).due to climate change. The prospects are particularly bad in Northern Africa. The demand for water in this region is expected to grow by at least 3% annually until 2020 as populations increase; economies develop coupled with rapid urbanization. Thus, surface water contamination is a growing problem with serious implications on public health (Amiri and Eslamian, 2010; Begum *et al*., 2011; Mia *et al*., 2012).

Climate change will also alter the suitability of land for cultivated or natural pasture and any rise in sea level will reduce land availability. It will also alter water availability and change the efficiency of production through changes in temperature. Increasing temperature are likely to have a positive effect on crops in temperate regions due to longer growing season (Reynolds *et al*., 2010). However, this is not the case in the tropics, most crops/pasture grow very fast and get lignified at maturity, which reduces digestibility of such crops/pasture as forage. Increasing temperature accelerates decomposition of soil organic matter, releasing stored carbon into the atmosphere. Also, the preservation of pasture through silage making is affected, extremely high oxidation, fermentation and effluent losses are very common which leads to poor quality silage unless additives are used (Arbabi and Ghoorchi, 2010) which in most case is beyond the reach of the resource poor farmers. However, in drought vulnerable areas in Africa, high densities of livestock associated with more intensive production systems cannot be supported. Thus, backyard and mobile systems may be more suited to the changing climate, given their small scale but may be more difficult to monitor and control.

Africa is home to more than 50,000 known plant species, 1,000 mammal species and 1,500 bird species (UNFPA, 2001). This diverse biological heritage is at risk in all sub-regions due to climate change leading to severe biodiversity depletion. As local conditions change, so too is the spread of livestock diseases especially MLK that cuts across several borders. This is due to changes in prevalence of the host species, in most cases weakened/malnourished animals are more susceptible as well as the suitability of environmental conditions for pathogen transfer exacerbated by climate change.

In the past, pastoralists were better able to withstand drought because they were more freely able to move to productive pastures (Amiri and Eslamian, 2010). In Africa, due to the expropriation of dry season grazing and watering areas by governments for the establishment of large-scale commercial farming, National Parks, Ranching, Tourist sites, etc have restricted pastoral mobility which impinges on their livelihood and food security. Most of these land expropriated by government in some cases cut across seasonal migratory routes. Thus, the wet season grazing areas are now grazed continuously throughout the year, leading to severe over-grazing and soil erosion.

Another feature of range degradation that impacts on MLK due to climate change is bush encroachment-the invasion onto grazing lands of undesirable woody species, unpalatable fobbs and the loss of grass layer (Amiri and Eslamian, 2010). Bush encroachment is prominent in rangelands where grazing pressure is high. Traditionally, pastoralists use bush burning as a tool for range management to control undesirable plant species. Burning removes moribund grass, renews the pasture and reduces tree saplings. Following the official banning of bush fires most woodlands have thickened, with tree regeneration out competing the herbaceous layer.

Drought is normal occurrence in Africa's drylands and is a key reason why MLK, rather than crops, is the production strategy of choice (Hesse, 2010; Averti and Dominique, 2011). It is true in Africa, that if they animals do not move, that's the end of the animal. A 250% growth in demand for livestock products is anticipated for the Sahel and West Africa by 2025 due largely to a growing urban population particularly in the coastal region (Delgado *et al.*, 1999). Given these projections, the incidence of malnutrition and related health disorders could rise significantly within this region as livestock products rich in essential nutrients become more scarce. Such scarcity will lead to escalating cost of these products beyond the reach of indigent local people. Imported substitutes are certainly not a solution as the cost will even be more prohibitive. However, there will also be economic impacts through fluctuations in product prices, high marketing transaction costs, loss of weight of animals on long treks, threats of animal being stolen on route and insecurity in the border lands. Such instability will threaten the smallholder MLK units commonly found in Africa.

THE WAY FORWARD (COPING STRATEGIES WITH CLIMATE CHANGE)

Livestock mobility is a modern approach to poverty alleviation and improve livelihood. In Africa, cross-border migration still predominates (Henry *et al.*, 2004) and contributes significantly to the global GHGE. Potential exist to reduce the adverse effects of climate change on global environment. Africa and other developing countries hold promise to achieve an estimated 70% of the technical mitigation potential (Smith *et al.*, 2007). However, evidence suggests that very little progress has been made to implement mitigation measures on a global scale (Gill *et al.*, 2010). Nevertheless, the long-term basis for developing mitigation practices in MLK in Africa and other developing countries is encouraging.

Where mobility is secured, MLK has massive environmental benefits, can adapt to climate change and present African government with grasslands generating revenue as carbon sinks (De Jode, 2009; Moundzeo *et al.*, 2011). Thus, African governments have to reconcile a vast number of conflicting national demands and deal with the major challenge of today's world-climate change. Significant benefits can come from improvements in livestock, manure, pasture, crop and soil management and bio-energy (Reynolds *et al.*, 2010).

Changes in livestock nutrition using improved forages rather than concentrates will produce many benefits. Mitigating GHGE through reduced concentrate feeding and increase in forage intake is a coping strategy and an important mitigation option (Hortenhuber *et al.*, 2010). However the use of wireless rumen sensors in ruminant nutrition research could also assist in providing the best combination of pasture/concentrate that produces the least emission rates for use by farmers (Kilic, 2011). This strategy could be very feasible under intensive feedlot and dairy operations. Similarly, the effect of biological N-fixation can help lower GHGE, particularly the planting of legumes that fix N. Also the recycling of cattle excreta as fertilizer substantially reduces GHGE of about 10% (Van Bruchem *et al.*, 1999) while increasing soil fertility, nutrient uptake and yield in crops (Onwudike, 2010; Kishor *et al.*, 2010). Generally, where nutrient cycles are closed, gaseous N-emissions (N_2O) are potentially lower. The greatest mitigation potential for carbon sequestration comes from improved soil management especially grasslands. It is estimated that it can contribute almost 90% to the technical potential (Smith *et al*., 2007; Reynolds *et al*., 2010). There is increasing interest in exploring the value of MLK in mitigating the impact of climate change, with the carbon sequestration capability of Africa's pastures emerging as a real opportunity for the drylands. Thirteen million km^2 of grassland are found in Africa (Reid *et al*., 2004). Grasslands store approximately 34% of the global stock of CO_2-a service worth $7 per hectare (Costanza *et al*., 1997). It is important to note that grasslands capacity to store carbon is significantly reduced in heavily degraded areas or where LUCs occur.

Thus, ways to offset the potential negative impacts of climate change driven adaptations in MLK need to be identified and regulatory mechanisms and laws initiated to raise awareness and help monitor and deliver mitigation technologies. The assistance of African governments on this aspect will be appreciated. Formal education systems and policies should give greater weight to traditional local knowledge of those whose livelihoods depend directly on the integrity of the natural resource base (Tacoli, 2011; Anya *et al*., 2011). More so, indigenous knowledge comprises a wide range of accumulated experience about natural resource management that holds value for policy making. Thus, combining it with modern scientific knowledge in natural resource management and use will provide the way forward.

Rainfall/water use is a key determinant factor for survival of MLK. Using their indigenous knowledge, they forecast climate outlook and adopt effective coping strategies. Government and policy makers concerned with climate change need to listen and learn from this useful knowledge. Incorporating climate change adaptation into development plans and strategies by African government is another option. Climate change models for MLK environments in Africa suggest increasing variability and unpredictability (Behnke and Scoones, 1993; Averti and Dominique, 2011). In theory, MLK should be better adapted to deal with this variability than other land use systems. Development planning, from the design to the location of key services and resources should be used to reinforce this adaptability. Thus scenario planning (Cavanna and Abkula, 2009) can be employed to help pastoralists influence policy decisions that affect their livelihoods. Scenario planning provides a framework within which pastoralists can critically analyze their situation and marshal their own arguments to advocate for the future they desire. In this direction, some African governments introduce nomadic education for migrant farmers. Ultimately school based education often conflicts with mobility patterns. Thus, no improvement of the current school-based system seems likely to be able to avoid this negative impact on the efficiency and reliability of the pastoral system. However, including pastoralists in 'Education for All' as observed by most African governments requires dedicated and specific set of competencies. It actually requires a shift in focus from tactics to strategy (Kratli and Dyer, 2009). Under this strategy, since pastoralists see themselves as agents of change, working with governments will shape policy decisions that will mitigate climate change without jeopardizing their age old livelihoods.

In Africa, water scarcity and uncertainty with extremes of weather are common. There is no doubt that these disasters will increase in the coming decades due to climate change (Knox *et al*., 2009). Technologies will need to be identified that reduce water wastage, maintain quality and make more efficient and effective use of available resources within livestock systems. Finally, there is an urgent need to establish and improve monitoring framework for developing countries to improve basal GHGE assessment and monitor progress through mitigation activities. The time to act is now. Barriers to implementation are not likely to be overcome easily without suitable policies/economic incentives and other programmes especially as it concerns MLK and livelihoods in Africa.

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