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Climate Smart Livestock System; Review

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Abstract

Summary:
Climate smart livestock is livestock systems that are resilient to climate change and offer efficient emission mitigation potential without compromising livestock productivity, food security and livelihoods. The main principle of climate smart livestock is efficient use of natural resources and protecting livestock sector from adverse environmental impacts. Climate smart livestock approaches need to take into consideration production systems and supply chains. Livestock production system specific climate smart livestock practices are designed such as land-based system, mixed system and landless system for efficient use of natural resources and strategy for protecting livestock sector from adverse environmental impacts. Climate-smart livestock strategies include mitigation (to reduce the sources of greenhouse gas) and adaptation (to reduce the vulnerability of climate change effects). Mitigation options are available along feed production, enteric fermentation and manure management. Livestock's role in adaptation practices relates to organic matter and nutrient management. Livestock production system resilient to climate change includes grazing management, early warning systems and insurance, feed management, waste management and integrated soil-crop-water management. In addition, identification of combinations of mitigation and adaptation practices that are adapted to specific production systems and environments (combined management of feed and manure) need to be explored. Livestock producers can reduce adverse effects of climate change through application of principles of climate smart livestock so as not to affect livestock productivity, food security and livelihoods.
Key words: adaptation; climate change; greenhouse gas; mitigation, resilience.

1. Introduction:

Worldwide, expanding population pressure, urbanization, economic growth and increasing income are leading to increased consumption of animal-based foods and greater commercialization with subsequent need for increased livestock production (Sidahmed, 2008). On the other hand, the need to increase livestock production and productivity has a direct impact on the environment and climate through increased emissions. This global problem has necessitated the concept of climate-smart livestock. Climate smart livestock is livestock systems that are resilient to climate change and offer efficient emission mitigation potential without compromising livestock productivity, foodsecurity and livelihoods. It also addresses the impact of livestock on climate and mitigates greenhouse gas (GHG) emission from livestock production that cause climate changes or global warming (Koslowski et al., 2012).
Livestock are identified as having a biggest impact on climate by generating GHGs like methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2) (FAO, 2013; IPCC, 2014).The principal sources of N_2O are manure and fertilizers used in the production of feed. The biggest source of CH_4 is enteric fermentation in the digestive process of ruminants. Livestock production is also an important driver of deforestation and associated CO_2 emissions both directly, as forests are cut down to provide pasture or degraded through animal grazing, and indirectly expansion of cropland into forest for human and animal feed (Bailey et al., 2014).
The usual approach to considering what actions might be taken in response to climate change is to break the problem up into two: what people might do to cope with the impacts of climate change, given that they are going to occur adaptation; and what actions people might take to lessen the impacts of human activity on the climate

system is mitigation. These are really two sides of the same coin (Thornton and Herrero, 2010).

Particularly for people vulnerable to climate change, adaptation options will be needed. There are various options in relation to livestock systems that may be viable in many situations for pastoralists and smallholders farmer that could reduce the negative impacts of livestock on climate (mitigation) while at the same time increasing household food security, income and reducing vulnerability (FAO, 2013).

Climate smart livestock practices are based on farming system, such as land-based system, mixed system and landless system that used for efficient use of natural resources and strategy for protecting livestock sector from adverse environmental impacts. Livestock production system resilient to climate change includes grazing management, early warning systems and insurance, feed management, water management and efficiently uses, diversification to climate-resilient agricultural production systems, and integrated soil-crop-water management (FAO, 2009).

Significant productivity improvements are needed to meet growing food security and development requirements, while minimizing inappropriate resource use and GHG emissions. Mitigation and productivity gains in livestock sector have been achieved through, application of science and advanced technology like sourcing low-emission feed, waste management, improved feed conversion, vaccination, pasture management, sustainable soil management and general improvements in animal husbandry (FAO, 2010). Climate change is a global issue. Increasing the awareness on mitigation and adaptation mechanisms to minimize effects of climate change is hoped to be beneficial. In light of the above points, the objectives of this review paper are to highlight:

- The impacts of livestock on climate, the adaptation and mitigation measures needed to minimize the contribution made by livestock production to climate change and
- The principles and main strategies of climate smart livestock.

2. Impact of Livestock on Climate:

The livestock sector is a major contributor to climate change by generating significant emissions of CH_4, N_2O, and CO_2. Livestock contribute to climate change by emitting GHGs either directly, e.g. from enteric fermentation and manure management or indirectly, e.g. from feed-production activities and conversion of forest into pasture (FAO, 2006).

CO_2 emission has more impact on radiative forcing than any other GHG. It has other impacts too: fertilizing effect on many plants and rapid injection to atmosphere causes acidification of the ocean, with negative effects for organisms (MEA, 2005). Livestock may account for 9 percent of global anthropogenic emissions of CO_2. There is considerable uncertainty in such estimates, however, the difficulties of estimating losses from such sources as deforestation and pasture degradation. There is also considerable variation between types of farming system and regions (Steinfeld et al., 2006).

Like CO_2, CH_4 has a positive radiative forcing on climate: the global warming potential of CH_4 is twenty-one times higher than that of CO_2 (UNFCCC, 2008), although it is much shorter-lived in the atmosphere. It also has impacts on high-atmosphere ozone formation (MEA, 2005). Livestock account for 35-40 percent of global anthropogenic emissions of CH_4, via enteric fermentation and manure, which together account for about 80 percent of agricultural emissions (Steinfeld et al., 2006).

The third important GHG is N_2O, a powerful, long-lived gas, its global warming potential is 310-times greater than CO_2 (UNFCCC, 2007). Nitrous oxide also has impacts on stratospheric ozone depletion. Ecosystem sources (mostly soil micro-organisms in a wide variety of environments) account for about 90 percent of all emissions (MEA, 2005). Livestock activities contribute substantially in two ways: in the use of manure and slurry as fertilizers, and through the use of fertilizers (Steinfeld et al., 2006)

3. Adaptation and Mitigation Needs

The usual approach considering what actions might be taken in response to climate change is to break the problem up into two: what might people do to cope with the impacts of climate change, given that they are going to occur adaptation and what actions might people take to minimize the impacts of human activity on the climate system mitigation (Thornton and Herrero, 2010).

3.1. Adaptation:

Adaptation is initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Adaptation options are needed to reduce vulnerability to future climate change. There are barriers, limits, and costs, but these are not fully understood (IPCC, 2007). Possible adaptive responses, range from technological options (such as growing more drought tolerant crops), through behavioral (such as changes in dietary choice) and managerial (such as different farm management practices), to policy (such as planning regulations and infrastructure development) (Kurukulasuriya and Rosenthal, 2003).

Three adaptation options are defined as micro level, income-related responses and technological developments. Micro-level adaptation options include farm production adjustments such as diversification of crop and livestock production; changing land use and irrigation. Income-related responses are targeted to drought and flood insurance schemes. Technological developments include such activities like the development and promotion of new crop varieties, improvements in water and soil management, and improved animal health (Thornton and Herrero, 2010).

Approach to addressing the challenges of climate change (in Africa, specifically) that depends on a close engagement with climate variability. A risk management approach is a very effective way to bring the issues associated with climate change (Washington et al., 2006). Understanding and dealing with current levels of climate variability can provide one entry point to the problems posed by increasing variability in the future and to the options that may be needed to deal with it. However, there are still difficult problems to be addressed relating to the uncertainty of climate projections and projected impacts and how this uncertainty can be appropriately treated in the search for social relevance (Thornton and Herrero, 2010). This uncertainty of climate can be solved by well research design, testing and implementation. This may involve searching for homologues of future climates that exist now, where breeding and selection can be carried out (Wilby et al., 2009).

3.2. Mitigation:

Mitigation is anthropogenic intervention to reduce the sources of GHG. There is substantial economic potential for the mitigation of global GHG emission, but some agricultural practices collectively can make a significant contribution at low cost by, reducing carbon footprint and reducing GHG emission (IPCC, 2007).

Improving crop and grazing land management to increase soil carbon storage; restoration of peaty soils and degraded lands; improved livestock system and manure management to reduce CH_4 emissions; improved nitrogen fertilizer application techniques to reduce N_2O emissions; and improved energy efficiency in general improvements in crop yields are also used for future to have played a role in reducing GHG emissions (Smith et al., 2008).

Technical options for mitigating emissions from livestock in developing countries do exist, there are various problems to be overcome, related to incentive systems, institutional linkages, policy reforms, monitoring techniques for carbon stocks, and appropriate verification protocols, for example for the pastoral lands, and the conclusion is that mitigation activities have the greatest chance of success if they build on traditional pastoral institutions and knowledge, while providing pastoralists with food security benefits at the same time (Reid et al., 2004).

The livestock mitigation debate is evolving very rapidly in the developed countries. Reductions in livestock product consumption have been urged as a contribution to the GHGs mitigation debate and there has been a considerable role of livestock in CH_4 production and whether shunning meat can help to combat climate change. Another way of reducing CH_4 would be to switch from ruminant to mono gastric meat, though this could put more pressure on grains and increase their price (McMichael et al., 2007).

Ethiopia has developed mitigation and adaptation strategy which is called Climate Resilience Green Economy (CRGE). It is an integral part of the 5 year Growth and Transformation Plan (GTP) aimed at creating a green national economic growth. Four pillars of the Ethiopian green economy strategy outlined in CRGE include improving crop and livestock production practices for improving food security and farmer income while reducing emissions. It is also concerned with the protection and re-establishing forests for their economic and ecosystem services; including as carbon stocks. It also thrives to expand electricity generation from renewable sources of energy for domestic and regional markets. The last is the use of appropriate advanced technologies in industry, transport and buildings (Addisu and Tefera, 2014).

3. Climate Smart Livestock:

3.1. Principle

According to FAO (2013), climate smart livestock is based on two major principles which include efficient use of resources and building resilience.

3.1.1. Resource use efficiency:

Efficient use of natural resources is a crucial strategy for protecting growth in the livestock sector from adverse environmental impacts. Efficiency in the use of natural resources is measured by the ratio between the use of natural resources as input to the production activities and the output from production, e.g. amount of feed per unit of milk produced (Westhoek et al., 2011).

Improving the feed to food conversion efficiency in animal production systems is a fundamental strategy for improving the environmental sustainability of the sector. A large volume of food is wasted even before it reaches the consumer. It is suggested that about one-third of food produced is wasted. Reduction of waste along the animal feed chain can substantially contribute to reducing the demand for resources, such as land, water, energy, as well as other inputs such as nutrients (FAO, 2011).

The current prices of inputs, such as land, water and feed, used in livestock production often do not reflect true scarcities. Consequently, there is the overutilization of resources by the sector and inefficiencies in production processes. Any future policies to protect the environment will have to introduce adequate market pricing for natural resources. Ensuring effective management rules and liability, under private or communal ownership of the resources, is a further necessary policy element for improving the use of resources (FAO, 2013).

3.2.1. Building resilience through: buffering and risk management at farm and system level:

Traditionally, livestock producers have been able to adapt to various environmental and climatic changes. Now however, expanding populations, urbanization, economic growth, increased consumption of animal-based foods and greater commercialization have made traditional coping mechanisms less effective as a result, the identification of coping and risk management strategies has become very important (Sidahmed, 2008).

Particularly in pastoral and agro-pastoral systems, livestock are key assets and fulfill multiple economic, social, and risk management functions. Livestock is also a crucial coping mechanism in variable environments. As this variability increases, livestock will become more valuable. For many poor people, the loss of livestock assets means a collapse into chronic poverty and has long-term effects on their livelihoods (FAO, 2013). A wide range of adaptation options are available. Possible adaptive responses include technological options such as behavioral modifications e.g. changes in dietary choices; managerial choices e.g. different farm management practices; and policy alternatives e.g. planning regulations and infrastructural development (Kurukulasuriya and Rosenthal, 2003; IPCC, 2007).

Some adaptation options may be appropriate for short-term but others for the long-term (or both). In the short-term, adaptation to climate change is often framed within the context of risk management (Washington et al., 2006). It outlines an approach for addressing the challenges of climate change that depends on a close engagement with climate variability, helping decision makers understand and deal with current levels of climate variability which can provide one entry point to the problems, posed by increasing variability in the future and the options that may be needed to build resilience. However, there are still problems to be addressed concerning the uncertainty of climate projections and projected impacts and how this uncertainty can be appropriately treated when determining response options (Wilby et al., 2009).

Longer-term approaches to adaptation are often described in terms of 'climate-proofing development'. These approaches may involve system changes (e.g. a change in the set of commodities produced or the shift from extensive to mixed systems) or the adoption of new technology. There may be long times between the identification of a problem and the development of readily available and appropriate technology (Burke et al., 2009).

3.3. Main Strategies:

The strategies for climate smart livestock vary with the existing livestock production systems which include land-based systems, mixed systems and landless systems (FAO, 2013).

3.3.1. Land-based system:

There are several climate-smart options available for land-based grazing systems; their applicability to low-input systems with infrequent human intervention tends to be quite limited. For land-based grazing systems, the main mitigation options include reductions in enteric CH_4 emissions and CO_2 removals through soil carbon sequestration. The major climate-smart livestock options for land-based livestock system include grazing management, pasture management and nutrition, breeding of livestock, vaccines, early warning systems and insurance against calamities considering the capacities of the system to satisfy multiple climate-smart approaches. Manure management mitigation options are much more limited in land-based systems. (FAO, 2013).

3.3.1.1. Grazing management:

Grazing can be optimized by balancing and adapting grazing pressures on land. This optimization can increase grassland productivity and deliver mitigation and adaptation benefits. However, the net influence of optimal grazing is variable and highly dependent on baseline grazing practices, plant species, soils and climatic conditions (Smith et al., 2008).

Perhaps the most clear-cut mitigation benefits arise from soil carbon sequestration that results when grazing pressure is reduced as a means of stopping land degradation or rehabilitating degraded lands (Conant and Paustian, 2002). In these cases, enteric emission intensities can also be lowered, because with less grazing pressure animals have a wider choice of forage, and tend to select more nutritious forage, which is associated with more rapid rates of live weight gain (LWG). By restoring degraded grassland, these measures can also enhance soil health and water retention, which increases the resilience of the grazing system to climate variability (Rolfe, 2010).

One of the main strategies for increasing the efficiency of grazing management is through rotational grazing, which can be adjusted to the frequency and timing of the livestock's grazing needs and better matches these needs with the availability of pasture resources. Rotational grazing allows for the maintenance of forages at a relatively earlier growth stage. This enhances the quality and digestibility of the forage, improves the productivity of the system and reduces CH_4 emissions per unit of LWG (FAO, 2013). Rotational grazing is more suited to managed pasture system, for example, early grazing of summer pastures is a major cause of grassland degradation. Delaying grazing until the grass sprouts have reached a more advanced stage of maturity is an important sustainable grazing practice (Eagle et al., 2012).

Pastoralist traditional grazing management in Ethiopia is like kalo and livestock mobility. kalo/Soro/Tabala; is enclosed grazing area which is reserved for lactating, sick or young animals, so the rest herd grazes on pasture particularly in the dry season (Helland, 1994) and livestock mobility, a traditional strategy of nomadic herders for matching animal production needs with changing rangeland resources, can significantly enhance the resilience of these livestock systems to climate change (Morton, 2007).

3.3.1.2. Pasture management and nutrition:

Pasture management measures involve the sowing of improved varieties of pasture, typically the replacement of native grasses with higher yielding and more digestible forages, including perennial fodders, pastures and legumes (Bentley and Hagerty, 2008).
For example, grazing systems of substantial improvements in soil carbon storage and farm productivity, as well as reductions in enteric emission intensities, are possible by replacing natural cerrado vegetation with deep-rooted pastures such as Brachiaria (Thornton and Herrero, 2010).

However, there are far fewer opportunities for sowing improved pastures in arid and semi-arid grazing systems. The intensification of pasture production though fertilization, cutting regimes and irrigation practices may also enhance pasture productivity and quality. Improved pasture quality through nitrogen fertilization may involve tradeoffs between lower CH_4 emissions and higher N_2O emissions (Bannink et al., 2010).

3.3.1.3. Animal breeding:
It is based on selection of more productive animals as a strategy to enhance productivity and lower CH_4 emission intensities. Research has recently been done on the mitigation benefits of using residual feed intake as a selection tool for low CH_4 emitting animals (Waghorn and Hegarty, 2011). In general, it relies on crossbreeding strategies that make use of locally adapted breeds, which are tolerant to heat and poor nutrition, but also to parasites and diseases (Hoffmann and Vogel, 2008).

3.3.1.4. Vaccines:
Vaccines against methanogens (microorganisms that produce CH_4 as a metabolic by- product) in the rumen are a potentially useful mitigation option for ruminants in land- based grazing systems (Wright and Klieve, 2011).

3.3.1.5. Early warning systems and insurance:
3.3.1.6.
The use of weather information to assist rural communities in managing the risks associated with rainfall variability is a potentially effective (preventative) option for climate change

adaptation. However, there are issues related to the effectiveness of climate forecasts for livestock management that still need to be addressed (Hellmuth et al., 2007).

Earl warning system in Borena is the traditional system of weather prediction includes a variety of techniques; reading livestock intestines (uusa); locating and identifying astrological sign like star and cloud (dumensa) and animal behavior. Elders reported that the results of these traditional practices were cross-referenced against the Gada calendar's predictions of drought cycles. Traditional practices and the Gada cycle were used jointly to predict the likelihood and the severity of drought, allowing the Borena to plan ahead (Luseno et al., 2003).

Livestock insurance schemes that are weather-indexed (i.e. policy holders are paid in response to 'trigger events' such as abnormal rainfall or high local animal mortality rates) may also be effective where preventative measures fail (Skees and Enkh-Amgala, 2002). There may be limits however to what private insurance markets can do for large vulnerable populations facing covariate risks linked to climate change (UNDP, 2008).

Traditionally there are two-tiered insurance systems in Borena pastoral system. The first tier is busagonafa; a community-based restocking programs in which several Borena families, whose cattle have survived, give a cow to a Boran family that has lost their entire herd. The cow is a permanent gift and is intended to help the family begin to rebuild their herd. The second is amessa, a short-term loan extended from one Boran family to another in the form of a lactating cow. The Boran family that receives the lactating cow may keep the cow and use her milk for one lactation cycle (typically less than six months in Borana) and then must return the cow (Luseno et al., 2003; Hurst et al., 2012).

3.1.1. Mixed systems:

Mixed livestock systems serve multiple purposes and if well managed these systems may be among the most promising means of adapting to climate change and mitigating the contribution of crop and livestock production to GHG emissions. There are a number of agronomic techniques and livestock management practices that have proven to be effective in delivering multiple benefits (food security, and improved climate change mitigation and adaptation) but focus on livestock related interventions (FAO, 2013). Climate smart livestock options for the integrated mixed systems focus on integrated soil- crop-water management, water use efficiency and management, sustainable soil management, feed management and diversification to climate-resilient agricultural production systems.

3.1.1.1. Integrated soil-crop-water management:

Soil and water are intrinsically linked to crop and livestock production. For this reason, an integrated approach to soil and water management is vital for increasing efficiency in the use of resources, adapting to and mitigating climate change, and sustaining productivity. For example, by increasing the organic content of the soil, through conservation tillage, the soil's water holding capacity increases, which makes yields more resilient and reduces erosion (Lal, 2009).

Existing soil and water adaptation technologies include; erosion control; the use of crop residues to conserve soil moisture; and improved soil cover through cover crops. By increasing water infiltration, reducing evaporation and increasing storage of rainwater in soils, many crop managements practices (e.g. mulching, green manures and conservation tillage) will help land users in areas projected to receive lower levels of precipitation adaptation to climate change. Promoting the capture of carbon in the soil also mitigates climate change. Soil management practices that limit soil compaction reduce tillage and retain crop residues lower the potential for N_2O loss, increase soil carbon and at the same time improve yields. In addition, managing pests, diseases or weeds using technologies such as the 'pull-and-push technology' can contribute to improving the availability of food and animal feed in crop livestock systems (Lenné and Thomas, 2005).

3.3.1.7. Water use efficiency and management:

Water management is a critical component for adapting to climate change. A number of adaptation techniques and approaches that are specific to water management include: cultivation of crop varieties with increased resistance to extreme conditions; irrigation techniques that maximize water use; adoption of supplementary irrigation in rain-fed systems and water-efficient technologies to harvest water; and the modification of cropping calendars (timing or location) (FAO, 2011).

There are three strategies for improving livestock-water productivity in mixed crop- livestock systems: feed management (e.g. improving feed quality, increasing feed-water productivity, enhancing feed selection, strengthening grazing management); water management; and animal management (e.g. increasing animal productivity and health) (Descheemaeker et al., 2010; FAO, 2013).

3.3.1.8. Sustainable soil management:

Carbon sequestration in soils has the potential to mitigate climate change and support climate change adaptation (Pascal and Socolow, 2004). A climate-smart strategy involves creating a positive carbon stock in soils and ecosystems by using residues as mulch in combination with crop farming and integrated nutrient management (i.e. the appropriate application of both synthetic and organic fertilizer). In addition, soil carbon sequestration delivers numerous benefits by improving soil quality and other ecosystem services. Restoration of degraded soils, through increases in soil organic carbon pools, improves production, which helps foster food security and improves nutrition. Increasing the pool of soil organic carbon is also important for improving efficiency in the use of nitrogen and potassium. Water quality also improves through a greater control of non-point source pollution (Lal, 2009).

3.3.1.9. Feed management:

Crop residues can represent up to 50 percent of the diet of ruminants in mixed farming systems. While these feed resources provide an inexpensive feed source, they are usually of low digestibility and deficient in crude protein, minerals and vitamins. This low digestibility substantially limits productivity and increases CH_4 emissions. Increasing the digestibility of feed rations by improving the quality of crop residues, or supplementing diets with concentrates will reduce CH_4 emissions (Herrero et al., 2008). Other possible feed management practices in mixed farming systems include the use of improved grass species and forage legumes. Animal productivity can be improved by using a multidimensional approach for improving the quality and thereby the utilization of food- feed crops. This can also lead to a reduction in animal numbers, lower feed requirements and reduced GHG emissions (Blümmel et al., 2009).

3.3.1.10. Diversification to climate-resilient agricultural production systems:

The diversification of sensitive production systems can enhance adaptation to the short- and medium-term impacts of climate change. Transitions within mixed farming systems are already occurring. In some marginal areas, reductions in length of growing period and increased rainfall variability are leading to conversions from mixed crop–livestock systems to rangeland-based systems, as farmers find growing crops too risky in marginal environments (Thornton et al., 2009).

Changing the mix of farm products (e.g. proportion of crops to pastures) is an example of farm-level adaptation option. Farmers may reassess the crops and varieties they grow, and shift from growing crops to raising livestock, which can serve as marketable insurance in times of drought. They may also introduce heat-tolerant breeds that are more resistant to drought. For example, in a case study covering villages in three South African provinces, it was noted that during dry season farmers tend to reduce their investment in crops or even stop planting altogether and focus instead on livestock production (Thomas et al., 2007).

In most cases, these practices deliver multiple benefits. However, before long-term benefits can be received, there are some tradeoffs that need to be made in the short term with respect to emissions, productivity and food security. Consequently, despite the long-term benefits, poor subsistence farmers may not be willing or able to accept the short- term losses associated with some of these practices (FAO, 2013).

4.2.3 Landless systems:

Climate-smart options for landless livestock system (pig, dairy, and beef) are mainly related to manure management and enteric fermentation (ruminants). Because these systems are generally more standardized than mixed and grazing systems, there are fewer applicable options (UNFCCC, 2008; Gill et al., 2009). The major climate smart livestock options for landless system focus on improved waste management, improved feed conversion, sourcing low-emission feed, improving energy use efficiency and building resilience along supply chains.

4.2.3.1. Improved waste management:

Most CH_4 emissions from manure derive from swine, beef and dairies, where production is carried out on a large scale and manure is stored under anaerobic condition. GHG mitigation options include the capture of CH_4 by covering manure storage facilities (biogas collectors). The captured CH_4 can be flared or used as a source of energy for electric generators, heating or lighting. Energy generated in this way can offset CO_2 emissions from burning fossil fuel (AEBIOM, 2009).

Anaerobic digestion technology has been shown to be highly profitable in warm climates (Gerber et al., 2008). Recent developments in energy policy have also enhanced its economic profitability in countries such as Germany and Denmark (FAO, 2013). Manure application practices can also reduce N_2O emissions. Improved livestock diets, as well as feed additives, can substantially reduce CH_4 emissions from enteric fermentation and manure storage (FAO, 2006). Energy-saving practices have also been demonstrated to be effective in reducing the dependence of intensive systems on fossil fuels.

4.2.3.2. Improved feed conversion:

Treatment of animals with growth promoting substances can result in increased efficiency of production, e.g. treatment of milking cows with growth stimulant such as steroid resulted in an increase in milk production per unit intake (efficiency) and decrease in CH_4 emitted per kg milk (Ulyatt et al., 2002).

4.2.3.3. Sourcing low-emission feed:

Decreasing dietary fiber and increasing starch and lipid will reduce CH_4 emission. Improving the nutritive value of the feed given to animals by balancing the diet with concentrates, or by breeding improved pasture plants result in reduced CH_4 emission (Ulyatt et al., 2002).

4.2.3.4. Improving energy use efficiency:

Landless systems generally depend on greater amounts of fossil fuel energy than mixed and grazing systems (FAO, 2013). Improving energy use efficiency is an effective way to reduce production costs and lower emissions. Dairy farms are seen as having great potential for energy use efficiency gains. Energy is used for the milking process, cooling and storing milk, heating water, lighting and ventilation. Cooling milk generally accounts for most of the electrical energy consumption on a dairy farm in developed countries. Cows are milked at temperatures around 35 to 37.5ºC (FAO, 2009).

To maintain high milk quality, which includes keeping bacteria counts low, the raw milk temperature needs to be lowered quickly to 3 to 4ºC. Refrigeration systems are usually energy intensive. Heat exchangers cooled by well water, variable-speed drives on the milk pump, refrigeration heat recovery units and scroll compressors are all energy conservation technologies that can reduce the energy consumed in the cooling system. These technologies can reduce GHG emissions, especially in countries where the energy sector is emission intensive (Gerber et al., 2011).

4.2.3.5. Building resilience along supply chains:

Landless livestock systems depend on purchased inputs. Climate change contributes to increased price volatility of these inputs, especially feed, which increases the financial risks for stakeholders involved in the livestock supply chain. This is especially true where commodity stocks of inputs are kept at a minimum throughout the supply chain and buffering options against price hikes are limited. In addition, the changing disease patterns caused by climate change can quickly affect landless systems that heavily rely on transport in the supply chain (FAO, 2009).

Resilience can be achieved either by allowing chains to overcome the crisis or by creating the conditions for quick recovery after the crisis. Although little experience has yet been developed in this area, greater coordination among the different stakeholders involved in the supply chain, insurance schemes, buffers and stocks may contribute to a greater resilience of supply chains that rely on landless livestock systems (FAO, 2013).

4. Conclusion and Recommendations:

Climate smart livestock is livestock system that is resilient and adapted to climate change. Improved livestock system is resilient to climate change and helps to reduce emissions through, mitigation options that are available along the entire supply chain and mostly associated with feed production, enteric fermentation and manure management and adaptation practices relates to organic matter and nutrient management.

Based on the above conclusion the following recommendations are forwarded

- Awareness creation should be made on climate smart livestock systems to all involved in livestock production. Better climate information and technical advice to help farmers, better manage climate risk and reduce the economic impact of droughts.
- Focus on climate-smart risk management through enhanced seasonal forecasts, early warning systems, and strategic food reserves for the most vulnerable members of society.
- Develop communication methods about best practices to all relevant stakeholders and make them operational.
- Balance stocking rate to minimize overgrazing and destocking before drought to reduce risk of animal death.

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References:

1. Addisu, G. and Tefera, M. (2014). Ministry of environment and forest Country interaction work shop Copenhagen April 09, 2014. Climate Resilient Green economy Strategy (CRGE) /Low-Carbon Development Strategies (LCDS) in Ethiopia.
2. Bailey, R., Froggatt, A. and Wellesle, L. (2014). Energy, Environment and Resources. Livestock - Climate Change's Forgotten Sector. Global Public Opinion on Meat and Dairy Consumption. Pp.5-6.
3. Bannink, A., Smits, M. C. J., Kebreab, E., Mills, J. A. N., Ellis, J. L., Klop, A., France, J. and Dijkstra, J. (2010). Simulating the effects of grassland management and grass ensiling on methane emission. Journal of Agricultural Science, 148: 55-72.
4. Bentley, D. and Hegarty, R. (2008). Managing livestock enterprises in Australia's extensive rangelands for greenhouse gas and environmental outcomes: a pastoral company perspective. Australian Journal of Experimental Agriculture, 48: 60-64.
5. Blummel, M., Anandan, S. and Prasad, C. S. (2009). Potential and limitations of byproduct based feeding system to mitigate greenhouse gases for improved livestock productivity.In Proceedings of 13th biennial conference of Animal Nutrition Society of India, Bangalore. Pp. 68-74.
6. Burke, M. B., Lobell, D. B. and Guarino, L. (2009). Shifts in African crop climates by 2050, and the implications for crop improvements and genetic resources conservation. Global Environment Change, 19: 317-325.
7. Conant, R. T. and Paustian, K. (2002). Soil carbon sequestration in overgrazed grassland ecosystems.Global Biogeochemical Cycles, 16: 1143.
8. Descheemaeker, K., Amede, T. and Haileslassie, A. (2010).Improving water productivity in mixed crop-livestock farming systems of sub-Saharan. Africa.Agricultural water management, 97: 579–586.
9. Eagle, A. J., Olander, L. P., Henry, L. R., Haugen-Kozyra, K., Millar, N. and Robertson, G. P. (2012). Greenhouse gas mitigation potential of agricultural land management in the United States: a synthesis of literature, 3rd Edition. Durham, USA, Nicholas Institute for Environmental Policy Solutions, Duke University. Pp. 10-14.
10. European Biomass Association (AEBIOM). (2009). Development in energy policy and economic profitability.
11. Food and Agricultural Organization (FAO). (2006). Livestock's long shadow: Environmental Issues and Options. Rome.
12. Food and Agricultural Organization (FAO). (2009). The State of food and Agriculture Livestock in the Balance Food, Rome.
13. Food and Agricultural Organization (FAO). (2010). Climate-Smart Agriculture Policies, Practices and Financing for Food Security, Adaptation and Mitigation/Food and Agriculture Organization of the United Nations (FAO) Vaile delle Terme di Caracalla00153 Rome. Available at Italywww.fao.org/climatechangeclimate- change@fao.org (Accessed on March 13, 2015).
14. Food and Agricultural Organization (FAO). (2011). Land and water options for climate change adaptation and mitigation in agriculture. Thematic background paper for the state of the World's Land and Water Resources for Food and Agriculture (SOLAW) Managing systems at risk. Rome. Available at www.fao.org/publications (Accessed on March 3, 2015).
15. Food and Agricultural Organization (FAO). (2013). Climate-smart agriculture source. ISBN 978-92-5-107720-7 (print) E-ISBN 978-92-5-107721-4 (pdf) Available at www.fao.org/publications (Accessed on March 13, 2015).
16. Gerber, P. J.; Carsjens, G. J., Pak-uthai, T. and Robinson, T. P. (2008). Decision support for spatially targeted livestock policies: Diverse examples from Uganda and Thailand. Agricultural Systems, 96 (1-3): 37-51.
17. Gerber, P., Vellinga, T., Opio, C. and Steinfeld, H. (2011). Productivity gains and greenhouse gas intensity in dairy systems. Livestock Science, 139: 100-108.

18. Gill, M. P., Smith, P. and Wilkinson, J. M. (2009). Mitigating climate change: the role of domestic livestock. Animal, 4 (3): 321-322.
19. Helland, J. (1994). Development interventions and pastoral dynamics in Southern Ethiopia: A discussion in Borana pastoralism. Working Papers in African studies: Boston University MA, Natural Recourses Management Pp. 186.
20. Hellmuth, M. E., Moorhead, A., Thomson, M. and Williams, J. (2007). Climate risk management in Africa: learning from practice. Climate and Society, No.1. Palisades, NY, the International Research Institute for Climate and Society (IRI). Pp 221.
21. Herrero, M., Thornton, P. K., Kruska, R. and Reid, R. S. (2008). Systems dynamics and the spatial distribution of methane emissions from African domestic ruminants to 2030. Agriculture, Ecosystems and Environment, 126: 122-137.
22. Hoffman, M. T. and Vogel, C. (2008). Climate change impacts on African rangelands. Rangelands, 30: 12-17.
23. Hurst, M., Jensen, N., Sarah, H., Sharma, A. and Jennifer, A. Z. (2012). CGIAR and Research and Program on and Climate Change, Agriculture and Food Security (CCAFS) and CCAFS Working. Pp 15-17.
24. Intergovernmental Panel on Climate Change (IPCC). (2007). Climate Change: Impacts, Adaptation and Vulnerability. Summary for policy makers. Available at: http://www.ipcc.cg/SPM13apr07.pdf (Accessed on March 14, 2015).
25. Intergovernmental Panel on Climate Change (IPCC). (2014). Edenhofer, O., Pichs- Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, A., Brunner, A., Eickemeier, P., Kriemann, B., Savolainen, J., Schlömer, S., von Stechow, C., Zwickel, T. and Minx, J. C. Climate Change, (2014): Mitigation of Climate Change, Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,: (eds) Cambridge, UK, and New York: Cambridge University Press. Pp 6-7.
26. Koslowski, F., Wilkes, A. and Moran, D. (2012). Developing climate-smart livestock systems in Inner Mongolia, China. A paper presented at the 86th Annual Conference of the Agricultural Economics Society, University of Warwick, United Kingdom. Warwick University, Coventry, UK. Available at: http://purl.umn.edu/135111 (Accessed on March 5, 2015).
27. Kurukulasuriya, P., Rosenthal, S. (2003). Climate change and agriculture: a review of impacts and adaptations. Climate Change, World Bank Series Washington. Pp.91.
28. Lal, R. (2009). Soil and water management options for adaptation to climate change. Adapting agriculture to climate change, A. Eaglesham and R.W.F. Hardy, eds. Netherland African Busness Council (NABC) twenty-first annual conference,Saskatoon. Pp. 222.
29. Lenné, J. M. and Thomas, D. (2005). Addressing poverty through crop-livestock integration: the contribution of past research to future challenges. Integrating livestock-crop systems to meet the challenges of globalization, P.Rowlinson, C. Wachirapakorn, P. Pakdee, and M. Wanapat, eds. AHAT/BSAS International Conference, Khon Kaen, Thailand. Pp. 13-26.
30. Luseno, W. K., McPeak, J. G., Barrett, C. B., Little, P. D. and Gebru, G. (2003). Assessing the value of climate forecast information for pastoralists: Evidence from Southern Ethiopia and Northern Kenya. World Development, 31(9): 1477- 1494.
31. McMichael, A. J., Powles, J. W., Butler, C. D. and Uauy, R. (2007). Food, livestock production, energy, Climate Change, and Health. The Lancet. Pp. 255-261. http://www.bioquest.org/wp-content/blogs.dir/files/2009/06/ecosystems-and-health.pdf
32. Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. Proceeding of the National Academy of Science (PNAS), 104: 19680-19685.
33. Pascal, S. and Socolow, R. (2004). Stabilization wedges: solving the climate problem for the next 50 years with current technologies. Science, 305: 968-972.
34. Reid, R. S., Thornton, P. K., McCrabb, G. J., Kruska, R. L., Atieno, F. and Jones, P. G. (2004). Is it possible to mitigate greenhouse gas emissions in pastoral ecosystems of the tropics? Environment, Development and Sustainability, 6: 91-109.
35. Rolfe, J. (2010). Economics of reducing grazing emissions from beef cattle in extensive grazing systems in Queensland. The Rangeland Journal, 32: 197-204.
36. Sidahmed, A. (2008). Livestock and climate change: coping and risk management strategies for a sustainable future. Livestock and Global Climate Change conference proceeding, Tunisia. Pp. 976-977.
37. Skees, J. R. and Enkh-Amgala, A. (2002). Examining the feasibility of livestock insurance in Mongolia. Policy Research Working, Washington D.C., World Bank.Pp. 2886.
38. Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H., Kumar, P., McCarl, B., Ogle, S., O'Mara, F., Rice, C., Scholes, B., Sirotenko, O., Howden, M., McAllister, T., Pan, G., Romanenkov, V., Schneider, U., Towprayoon, S., Wattenbach, M. and Smith, J. (2008). Agriculture in Climate Change Mitigation. Contribution of Working Group 3 to the 4rth Assessment Report of the Intergovernmental Panel on Climate Change. Greenhouse Gas Mitigation in Agriculture, 363: 789-813.
39. Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and De Haan, C. (2006). Livestock's long shadow: Environmental Issues and Options. FAO, Rome, Italy. Pp. 245-261.
40. Thomas, D. S. G., Twyman, C., Osbahr, H. and Hewitson, B. (2007). Adaptation to climate change and variability: farmer responses to intra-seasonal precipitation trends in South Africa. Climatic Change, 83: 301-322.
41. Thornton, P. K. and Herrero, M. (2010). The Inter-linkages between Rapid Growth in Livestock Production, Climate Change, and the Impacts on Water Resources, Land Use, and Deforestation. Development Economics. Office of the Senior Vice President and Chief Economis Available at 978-92-5-107721-4 (pdf) (Accessed on March 10, 2015).
42. Thornton, P. K., Van de Steeg, J., Notenbaert, A. and Herrero, M. (2009). The impacts of climate change on livestock and livestock systems in developing countries: a review. Agricultural Systems, 101: 113-127.
43. Ulyatt, M. J., Lassey, K. R., Shelton, I. D. and Walker, C. F. (2002). Seasonal variation inmethane emission from dairy cows and breeding ewes grazing ryegrass/white clover pasture in New Zealand. New Zealand Journal of Agricultural Research. Pp. 56-61.

44. United Nation Framework Convention on Climate Change
45. (UNFCCC). (2007). Challenges and opportunities for mitigation in the agricultural sector: technical paper. United Nation Framework Convention on Climate Change.
46. United Nations Development Program (UNDP). (2008). Human Development: fighting climate change. Human Solidarity, 792: 2000-2008.
47. United Nations Framework Convention on Climate Change (UNFCCC). (2008). Challenges and opportunities for mitigation. The Agricultural Sector.
48. Waghorn, G. C. and Hegarty, R. S. (2011). Lowering ruminant methane emissions through improved feed efficiency. Animal Feed Science Technology, 166: 291- 301.
49. Washington, R., Harrison, M., Conway, D., Black, E., Challinor, A., Grimes, D., Jones, R., Morse, A., Kay, G. and Todd, M. (2006). African climate change - taking the shorter route. American Meteorological Society, 87 (10): 1355-1366.
50. Westhoek, H., Rood, T., Van den Berg, M., Janse, J., Nijdam, D., Reudink, M. and Stehfest, E. (2011). The protein puzzle: the consumption and production of meat, dairyand fish in the European Union. The Hague, PBL Netherlands Environmental Assessment Agency.
51. Wilby, R. L., Troni, J., Biot, Y., Tedd, L., Hewitson, B. C., Smith, D. G. and Sutton, R. T. (2009). A review of climate risk information for adaptation and developmentplanning. International Journal of Climatology, 29: 1193-1215.
52. Wright, A. D. G. and Klieve, A. V. (2011). Does the complexity of the rumen microbial ecology preclude methane mitigation? Animal Feed Science Technology, 166- 167: 248-253.