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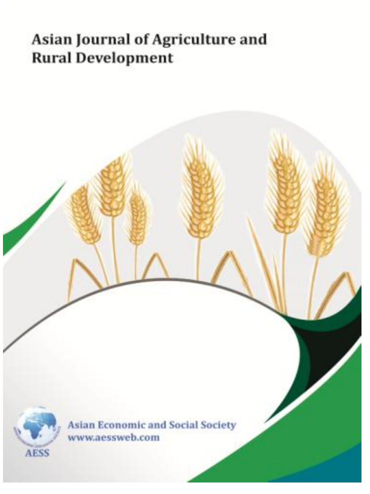

The Impact of Climate Change on Livestock Production amongst the Resource-Poor Farmers of Third World Countries: A Review

L. Musemwa (Risk and Vulnerability Assessment Centre, University Of Fort Hare, Alice 5700, RSA)

V. Muchenje (Department of Livestock and Pasture Science, University Of Fort Hare, Alice 5700, RSA)

A. Mushunje (Department of Agricultural Economics and Extension, University Of Fort Hare, Alice 5700, RSA)

L. Zhou (Risk and Vulnerability Assessment Centre, University Of Fort Hare, Alice 5700, RSA)

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The Impact of Climate Change on Livestock Production amongst the Resource-Poor Farmers of Third World Countries: A Review

Author(s)

L. Musemwa
Risk and Vulnerability Assessment Centre, University of Fort Hare, Alice 5700, RSA

V. Muchenje
Department of Livestock and Pasture Science, University Of Fort Hare, Alice 5700, RSA

A. Mushunje
Department of Agricultural Economics and Extension, University of Fort Hare, Alice 5700, RSA

L. Zhou
Risk and Vulnerability Assessment Centre, University of Fort Hare, Alice 5700, RSA

Abstract

The world is currently experiencing average high temperatures and low precipitation, frequent droughts and scarcity of both ground and surface water. The damaging effects of global climate change are increasing and most damages are predicted to occur in developing countries due to their over-reliance on low-input rain-fed agricultural production and their low adaptive capacity. Due to the erratic rainfall and high incidence of droughts which make crop production not feasible, the majority of the rural population in Third World Countries depends on livestock production for their livelihoods. The livestock sector is, however, considered very vulnerable to climate variability and change. Floods, droughts, diseases and poor grazing conditions are some of the factors currently causing significant livestock losses. The problems being encountered by the livestock farmers in most of the Third World Countries are expected to worsen in future due to the effects of climate change. This therefore makes the study of impact of climate change on livestock production a vital concern in the world, particularly in developing countries where many rural households depend on livestock production for their livelihoods. This article therefore looks at both the direct and indirect effects of climate change on livestock production. Strategies to curtail the effect of climate change on livestock production are also recommended in the paper.

Keywords: Erratic rainfall, developing countries, diseases, floods, local breeds, temperature variability

Introduction

Past land policies resulted in the majority of the resource-poor households in developing countries residing on marginal land, not suitable for crop production. The erratic rainfall and high incidence of droughts and low employment opportunities in these marginal areas, therefore, make a large majority of the population depend on livestock for their livelihoods (ISRDS, 2004; Coetzee et al., 2004; Musemwa et al., 2010). Livestock meet the multiple objectives that are desired by resource-poor people which include the provision of draught power, manure, cash sales, among other socio-economic functions (Chimonyo et al., 2000). Therefore, livestock production has a great potential for generating income for many rural households in marginal areas of many developing countries, thereby alleviating poverty and improving the livelihoods of the rural poor (Dovie et al., 2006; Simela et al., 2006). However, production of livestock is still a challenge in the Third World Countries due to poor management practices, high prevalence of pests and diseases, poor state of the grazing land and overgrazing (Muchenje et al., 2008). Natural grazing lands constitute the main feed resource for domestic livestock in most developing countries.

There is over-reliance on low input rain fed livestock production in developing countries (IPCC, 1996; Kabubo-Mariara, 2008). The problems facing resource-poor livestock farmers in most of the Third World Countries are going to be worse in the future due to the effects of climate change resulting in huge economic impacts (Midgley et al., 2011). This vulnerability is exacerbated by existing developmental challenges such as endemic poverty, complex governance and institutional dimensions; limited access to capital, including markets, infrastructure and technology; ecosystem degradation; and complex disasters and conflicts. Climate change is now therefore, recognised as one of the most serious challenge facing the world, its people, the environment and its economies (ECARD, 2008). Farming, particularly livestock production in marginal areas is thus in the front-line of the battle against climate change impacts. IPCC (2001) reported that the damaging effects of global temperature is increasing and most damages are predicted to occur in developing countries especially in Africa, where the region already faces average high temperatures and low precipitation, frequent droughts and scarcity of both ground and surface water.

Developing countries have warmed by almost 1 °C in the past century, faster than the global average (IPCC, 2001). Climatic conditions have become more variable. Rainfall has fallen considerably and droughts are more frequently experienced. Temperatures have become more extreme and floods more common (Midgley et al., 2011). Very little research has been conducted on the impacts of climate change on livestock, pests and diseases. The livestock sector is very important in many developing countries and is considered very vulnerable to climate variability and change. This therefore makes the study of impact of climate change to livestock production a vital concern in the world particularly in developing countries where many rural households depend on livestock for their livelihoods. This paper therefore looks at both the direct and indirect effects of climate change to livestock production. Adjustments will be necessary in order to counterbalance any negative impacts of a changing climate. Farmers must have the ability to adjust to changes by adapting farming practices. While there has been considerable international experience of various climate change-related activities aimed at livestock production, drawing adoption strategies from this experience is difficult. This paper will therefore, also attempt to elucidate some of the impact of climate change on livestock production reduction strategies that can be adopted by resource-poor farmers.

Main Effects of Climate Change to Livestock Production

The Intergovernmental Panel on Climate change (IPCC, 2001) highlighted that drought, floods and cyclones and extreme temperature conditions will severely affect agriculture, especially in developing countries due to less adaption capacity of these countries to climatic conditions. This sub-section therefore looks at both the direct and indirect impact of these factors to livestock production in developing countries.

Impact of Drought

A drought is an extended period of months or years when a region notes a deficiency in its water supply whether surface or underground water (Nepstad, 2007). Drought is not simply low rainfall, it occurs when there is an extended period of deficiency in precipitation (relative to what is considered normal), which is then insufficient to meet economic, social and environmental demands. According to Nepstad (2007), drought is a recurrent phenomenon in the world especially in dry land areas. Herders and farmers must continually adjust their practices in order to cope with variability. During droughts those on the land feel it most. Subsistence farming, which provides most people of the region with their food, depends on sufficient rainfall (Simela et al., 2006). Agriculture suffers first and most severely - yet eventually everyone feels the impact. Trees and grasses wilt and die and animals perish from hunger and thirst. During a drought, overgrazing leads to further degradation of pastures and arable areas in livestock farming areas. The deterioration of grazing capacity further reduces livestock numbers. In drier areas, scanty rainfall for a few years can kill vegetation permanently and poor land-practices only make it worse.

For instance, the 1991-1992 droughts which ravaged most of southern Africa killed more than one million cattle in Zimbabwe (SARDC, IUCN and SADC, 1994). During a drought period household herd sizes become smaller. In a study conducted by Scoones (1992) in Zimbabwe, a general shift toward smaller herd sizes resulting from mortality and loaning out was observed during drought periods. Stocklessness doubled as a result of the 1982-84 droughts in Zimbabwe. The birth rate of livestock was also heavily affected by the drought. High rates of distortion also occurred during the drought period in Zimbabwe. Birth rates only began to decline well in the drought period, decreased to zero at the drought peak. On the contrary, livestock sales were highest during the drought period.

The effect of drought on livestock varies across ecological zones (Scoones, 1992). The time required for drought injury to occur on livestock depends on the water-holding capacity of the soil, environmental conditions, stage of plant growth, and plant species. Plants growing in clay soils are more susceptible to drought stress than plants growing in sandy soils. The availability of key resource grazing patches, notably *dambos*, is more extensive in the sandy soil zone. This therefore results in the deterioration of veld condition in clay soils earlier than in sandy zones hence livestock in clay zones being affected first.

Impact of Floods and Cyclones

Floods and cyclone pose both a direct and indirect effect on livestock production in developing countries. They result in a direct loss of livestock and indirectly affect livestock by destroying infrastructure such as dip tanks and paddocks. For instance, during the 2009/2010 agricultural season, floods and cyclones damaged substantial areas of agricultural production in southern and central Mozambique, resulting in loss of livestock, livestock infrastructure and crops needed in livestock production (FAO, 2000). Preliminary estimates suggest that losses reached almost $8 million in the livestock sector. Livestock losses have been estimated at 20,000 cattle; 4,000 goats, sheep and pigs; and 180,000 chickens, but it must be noted that these numbers were at the low end of a range (with the high end approximately doubling these numbers) (World Bank, 2000). As livestock play an essential social and economic role in most developing countries, livestock loss will also deeply affect regional development. Smaller species which include poultry have virtually disappeared in the flooded areas, removing another source of revenue and nutrition from the resource-poor households.

In Pakistan during the 2010/2011 agricultural season, 158,412 animals perished due to floods; cattle heads worth 106 million dollars were lost in the north-western province only. After the floods, at least 2.3 million dollars was needed for treatment of sick animals and 1.3 million livestock faced severe feed shortages. Other than the losses of livestock, infrastructure for livestock production was also severely damaged and also disputes on ownership to livestock among farmers were triggered (Xinhua News Agency, 2010).

Another important factor of livestock production which can be affected by floods is labour. Labour is needed for livestock rearing, vaccination, treating sick animals as well as feeding the livestock. As a result of a flood event, people involved in livestock production may perish in extreme cases or may be affected health wise to the extent that they will not be fit to perform the duties required in livestock production. This results in the deterioration of livestock condition or death of livestock in some extreme cases. According to the World Bank (2000), the floods that occurred in Mozambique for instance forced at least 250,000 people, or approximately 50,000 families, to abandon their homes and their possessions which include livestock.

Impact of Extreme Temperatures

There is a range of temperature where livestock are neither too hot nor too cold and their performance is optimal. This temperature range is called the thermo neutral zone. It is the temperature range where the fewest nutrients are needed to maintain bodily functions (Kadzere et al., 2002; Boyles, 2008). Increase in atmospheric temperatures tend to have adverse impacts on livestock production (e.g. low milk production) through both declining forage quality and increased ambient temperature (Hanson et al., 1993, IPCC 1996). In pigs for instance, the general effects of high temperature are easily observed. The animals become lazy and tend to lie flat on the ground or floor (Myer and Bucklin 2001; Kerr et al., 2005). A rise in the ambient-environmental temperature above a certain point, results in the average daily weight gain dropping more rapidly than the daily feed consumption (Kouba et al., 2001; Collin et al., 2001; Myer et al., 1998).

In a study by Kerr et al. (2005) on pigs, body temperature increased with the rising ambient temperature, but the increase was relatively small until the higher temperatures were reached. As the temperature increased, the pulse rate declined. The rapid and immediate rise in respiration is notable and precedes any body temperature change. An increase in ambient temperature resulted in a decline in feed consumption. According to Adams et al. (1998) and Berman (2005) warmer temperatures are estimated to have a suppressing effect on livestock appetite, which leads to lower weight gain. Adams et al. (1998) observed that under a 5.0°C increase in temperature, livestock yields fell by 10% for cow/calf and dairy for a 1.5°C warming, yield loss was estimated at 1%.

Increase in temperature results in the spatial distribution and intensity of existing pests, and diseases which in turn affect livestock productivity or may cause death of livestock in some extreme instances. Diseases are a major constraint to both livestock production and marketing in the tropics (Devendra et al., 2000). Animal health issues are barriers to trade in livestock and their products, whilst specific diseases decrease production and increase morbidity and mortality (Düvel and Stephanus, 2000). According to ECARD (2008), most diseases are transmitted by vectors such as ticks and flies, the development stages of which are often heavily dependent on temperature. Cattle, goats, horses and sheep are also vulnerable to an extensive range of nematode worm infections, most of which have their development stages influenced by climatic conditions more particular temperature. Slenning (2010) highlighted that generalized warming will allow vectors to survive at higher elevations, allowing them to cross mountain ranges that currently limit their distribution. Changes in rain patterns and intensity, combined with shifts in temperature ranges, will change local environments allowing vectors to survive and migrate across areas that previously were barriers. Farmers will face the challenge of dealing with increased pest problems, or new pest challenges, within the constraints of what science can provide and within the world's pesticide authorisation regulatory framework (ECARD, 2008).

In contradiction, disease incidences could in fact dwindle in certain areas and for different populations as a result of climate change. For instance, Randolph (2008) found that as ambient temperatures rise, some ticks (*Ixodes ricinus*) are beginning questing behavior earlier in the year, before their mammalian host numbers rise via spring birthing. This increases tick mortality and decreases overall tick-borne disease incidence in those hosts. Climate change will decrease biodiversity, and pathogens, vectors, or hosts could be early victims (Lafferty, 2009). More mixed impacts are predicted for cooler regions. If the intensity and length of cold periods in temperate areas are reduced by warming, feed requirements may be reduced, survival of young animals enhanced and energy costs for heating of animal quarters reduced (Aydinalp and Cresser, 2008).

Extreme low temperatures in other parts of countries are also likely to have an impact on livestock production. The metabolic response to the stimulus of cold involves practically all the systems of the body. The striated muscles shiver, the heart beats faster, breathing becomes deeper, urine flow is increased and the sympathetic and pituitary controlled systems are activated so to elevate biological oxidations (energy expenditure or heat production) in all tissues. The result is an increase in the cow's requirements for energy (Kabuga, 1992). According to Boyles (2008, it is estimated that for every one degree below the critical temperature a cow's energy requirement (TDN) increases by 1 percent and for every ten degrees below the critical temperature the digestibility of the ration decreases by 1 percent. This means that when the temperature drops below the critical temperature the cattle need to be fed better. It may be that more or better hay needs to be fed.

Extreme low temperatures being experienced in other developing countries due to climate change also results in the protein content of grasses declining and the lignin content rising. Livestock lose condition when the quality of the natural pasture can no longer provide the nutritional needs of their bodies, partly because they ingest less grass due to the high lignin content and partly because the protein content of the grass they ingest is relatively low. For dairy cows for instance, the poor quality of the feeds during extreme colds render the dairy cows' deficient in protein, and therefore do not meet maintenance and production requirements (Smith and Akinbamijo, 2000; Shem, 1996). Research has also indicated that cattle tend to lose mass once the protein content of the veld they are grazing declines below 6% on a dry matter basis (Jayasuriya, 2000). The fall in crude protein content is also accompanied by an increase in fibre content. Thus, the animal is faced with insufficient amounts of a low quality and relatively indigestible feed. The situation can also be intensified by drought.

Feeds, when temperatures are low also, have a high content of dietary fibre ranging from 35 to 48%, which has a limiting effect on intake and digestibility of feeds (Dixon and Egan, 1987). Associated with dietary fibre are the anti-nutritive factors such as lignin and silica, which are known to inhibit microbial fermentation in the rumen (Deventra, 1993). Inadequate nutrition in the dry-season usually results in reduced body weight and condition scores in adult animals, poor milk yields and long calving intervals in nursing cows, retarded growth and increased mortality rates in calves. Also associated with poor nutrition is the increased susceptibility of animals to stress and disease challenges, which result in these animals performing below their expected genetic potential (Nadaraja, 1978). All these factors result in heavy economic losses to the farmer.

Adaptation Strategies

Approaches to climate change management in the livestock sector depend very heavily on the level of resources that national governments or donors or both are able and willing to commit (Morton et al., 2002). This level of resources is determined by a country's per capita income, its size, and the priority it enjoys among donors, but also by historical, political and cultural factors.

Improve Access to Weather Focus Information

None or poor provision of agricultural information is a key factor that has greatly limited agricultural development in developing countries (Bailey et al., 1999). Information delivery is critical in the process of enhancing the adaptive capacities of the rural areas to climate change. The lack of timorous and reliable information on weather or new technologies is severe in most communal areas of developing countries. Improved early warning systems and their application may also reduce vulnerability to future risks associated with climate variability and change. Using such climate information it may be possible to give outlooks with lead times of between 2 and 6 months before the onset of an event (Thomson et al., 2006). Such lead times provide opportunities for putting interventions in place. If information is made available resource-poor farmers would be able to obtain livestock movement permits or sell their livestock on time. Although considerable progress has been observed in the provision of communication systems such as telephone and cellular phone network facilities, communal farmers in developed countries still remain uninformed in terms of new weather focus information in advance as they use outdated equipment that make the probability of correct prediction very low resulting in farmers not even trusting the information in most instances.

Radio and other media such as churches and gatherings like traditional beer drinking ceremonies are still used as main source of weather focus information (Musemwa et al., 2008; Montshwe, 2006). However, access by smallholder livestock farmers to radios, televisions and internet is still limited. In most cases, information is broadcasted and written in English. This makes the information irrelevant to the majority of communal farmers who in most cases understand their local languages only (Montshwe, 2006).

Use of Local Breeds

Livestock pests and diseases form a major threat to livestock production in developing countries and climate change may aggravate the situation since a warmer climate could shorten the developmental cycle of many pests and disease agents. An integrated management approach combining biological and non-biological methods will be the best option to deal with an increased pest and disease pressure. Policies and development efforts to improve livestock production in the communal areas in developed countries such as South Africa for instance have been based on the use of fast growing imported breeds (Collins-Luswet, 2000; Musemwa et al., 2010). These are perceived to be superior to native breeds because of their large body size (Bester et al., 2005).

Contrary to this presumption, exotic breeds are failing to cope with the harsh climatic conditions being experienced in these areas (Muchenje et al., 2008). Consequently, farmers raising these imported breeds are incurring more production costs as a result of climate change. Use of local breeds such as the Nguni cattle in South Africa and the Mashona in Zimbabwe which are well adapted to the environment because they have evolved in those surroundings for thousands of years could lower the impact of climate change on livestock production in developing countries. Local breeds are known by their fertility and excellent resistance to ticks and immunity to tick borne diseases (Ferreira, 2008). Disease incidence and mortality are low in local breeds (Mapiye et al., 2007, Muchenje et al., 2008). For instance the South African local cattle breed (Nguni cattle) has survived without any dipping or dosing in areas where other cattle died within months. Bonsma (1980) and Muchenje et al. (2008) found that the Nguni carried the lowest tick numbers regardless of the species or season of the year however Muchenje et al. (2008) further noted that productivity of the Nguni cattle was not significantly influenced by whether they were dipped or not but Bonsmara and Angus steers showed significant drops in growth rate, liveweight and carcass characteristics as shown in Table 1.

Table 1: Least square means of daily gain and carcass characteristics of dipped Nguni, Bonsmara and Angus steers

Breed	Tick Control	N	Average daily gain (g/day)	Slaughter weight	Warm carcass weight (kg)	Dressing percentage	Eye muscle area (mm2)
Ngumi	Not dipped	25	197±11.9	220±8.0^{a}	111±4.5^{a}	50.3±0.84^{a}	3648±105^{bc}
	Dipped	13	210±12.3	227±10.7^{a}	116±6.1^{ab}	51.0±1.13^{ab}	3858±151.4^{bcd}
Bonsmara	Not dipped	15	241±11.2	265±9.6^{c}	142±5.4^{d}	53.8±1.01^{d}	3996±120.8^{d}
	Dipped	14	220±16.9	254±10.7^{bc}	135±6.1^{cd}	53.4±1.13^{cd}	3988±141.5^{cd}
Angus	Not dipped	6	205±29	240±11.1^{ab}	129±6.3^{bcd}	53.7±1.17^{cd}	3291±210.6^{a}
	Dipped	8	178±33.7	235±12.9^{ab}	123±7.7^{bc}	52.3±1.43^{bc}	3491±170.9^{ab}
Level of significance			NS	*	*	*	*

Means in the same column with different superscripts are different (*P<0.05), NS-Not significant
Source: Muchenje et al. (2008)

Besides their resistance to tropical diseases and parasites, the local livestock breeds are highly adaptable to poor quality grazing and conditions of excessive heat and humidity (Ndlovu et al., 2009; Musemwa et al., 2010). They also have adaptive traits such as walking ability, which enables it them to walk long distances in search of grazing and water (Ferreira, 2008; Muchenje et al., 2008). They are excellent foragers and can graze and browse on steep slopes and in thick bushes alike (Mapiye et al., 2007). According to Ndlovu et al. (2009), higher levels of blood urea have been recorded in the Nguni cattle than in other breeds (most significant during winter months) and although this finding is subject to ongoing research certain facts have been identified as possible catalysts:

- Nguni have a system of recycling urea through controlled kidney function and even drinking the urine of other animals in the herd during times of nutritional stress.
- Nguni are capable of selecting diet efficiently through higher intake of browse for increased protein ingestion
- The digestive system of the Nguni is more efficient in terms of cellulose break-down, release of nutrients and digestion of micro-organisms present in the system, millions of which are carried into the small intestines.

Apart from these adaptability features, local breed also are more profitable to farm with. Vorster (1964) compared the amount of beef produced by Afrikaner, Hereford and Nguni and he found that Nguni produced more beef per cow (kg of beef) than the other two breeds in Zimbabwe under commercial farming conditions. Barnard and Venter (1983) compared the net income of 5 breeds (Afrikaner, Hereford, Sanga, Santa Gertrudis and Simmentaler) in Namibia, marketing at 18 months of age directly offveld with no concentrate feeding. The Nguni (Sanga) generated the highest net income.

Apart from using local breeds farmers can change enterprises. For instance, during drought periods, pastoralists and agro-pastoralists change from cattle to sheep and goat husbandry, as the feed requirements of the latter are lower (Seo and Mendelsohn, 2006). Biotechnology research could also yield tremendous benefits if it leads to drought and disease resistant livestock specie (ECA, 2002). The use of emergency fodder, culling of weak livestock for food, and multi-species composition of herds to survive climate extremes is also another adaptation strategy that can be used by the resource-poor farmers during times of drought. Enhanced resilience to future periods of drought stress may also be supported by improvements in existing rain-fed livestock farming systems (Rockström, 2003), such as water-harvesting systems to supplement livestock during periods of low rainfall.

Shades and Ventilation

During times of high temperatures resource-poor farmers cannot afford to purchase materials to build either artificial or permanent shades. This therefore means poor resource livestock farmers can use trees as natural shade. In an experiment by Valtorta *et al*. (1997) the artificial shade structure did not differ from tree shades in terms of the effects on animal well-being. Trees are an excellent natural source of shade on the pasture. Trees are not effective blockers of solar radiation but the evaporation of moisture from leaf surface cools the surrounding air. A simple shade can reduce the animals' radiant heat load by 30% or more (Bond et al., 1967). According Valtorta et al. (1996;1997) shades are efficient in reducing heat stress in livestock. They found that protected dairy cows presented lower afternoon rectal temperature and respiration rate, and yielded more milk and protein. In beef cattle with access to shade, Mitlo¨ ehner et al. (2001; 2002), observed a reduction in core body temperature and respiration rate.

Stock Movement

Movement of livestock from regions affected by climate change i.e. droughts, for example, to alternative grazing areas is one of the strategies that can be adopted by resource-poor farmers. According to Scoones (1992), the movement of stock in drought affected regions can be done in two ways depending on the severity of the climate change impact. For instance if the drought is not too severe, movement of stock can be done locally away from the clay soil zone to the edge zone and on to the sandy soil zone areas. This is because drought has a lesser impact on grass production in the sandy soil zone. In addition the availability of key resource grazing patches, notably dambos, is more extensive in the sandy soil zone. If the drought is severe, movement of livestock is done across regions (movement outside the boundaries of a communal area).

In this process livestock can be loaned to both relatives and friends and often at some distance from the owner's home where climate change impact is less. In some instances, grazing can be hired from private land owners which is however a resource-poor farmer. However, resource-poor farmers can exchange grazing with some of their livestock. Movement of livestock outside the boundaries of communal areas is however difficult. To begin with, movement of animals outside their dip area is illegal without a permit from the Veterinary Department. Such permits are quite complex to acquire, requiring a series of visits to official offices and the signing of a number of forms. Movement is further restricted by specific veterinary regulations related to the control of Foot and Mouth Disease and required by the most developing countries (Coetzee et al., 2004; Montshwe, 2006; Musemwa et al., 2010). Policy restrictions on movement thus hamper flexible climate change response through stock movement.

Conclusion

The impact of climate change in developing countries to resource-poor livestock farmers is increasing significantly due to the fact that the farmers have limited adaption strategies. If policies which include allowing free movement of stock during periods of harsh climatic conditions could be put in place, the impact of climate change could be reduced quite significantly. The use of local breeds which are well adapted to harsh climatic conditions could also play an important role in minimizing the effect of climate change to livestock production. An integrated tree-livestock farming system could play a role in minimizing the impact of extreme temperature on livestock. The trees act as shades during times of high temperature reducing heat stress on livestock hence promoting livestock productivity. The provision of reliable weather focus information in developing countries in a user friendly manner could also provide livestock farmers with opportunities for putting interventions strategies in place before a bad event happens hence reducing the impact of climate change to livestock.

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