http://dx.doi.org/10.22161/ijeab/2.1.38 *ISSN: 2456-1878*

Vulnerability of the Livestock Sector in Changing Climate Conditions: A Case from India

Nirma Bora

Abstract— *In India, livestock sector plays an important role in socio-economic development of rural households. Over 70 percent of the country's rural households own livestock and a majority of livestock owning households are small, marginal, and landless farmers. The reality of climate change and the fact that life in the poorest and vulnerable economies will be worst affected is set to have far-reaching consequence on the animal and its owners. At the same time, livestock have always shouldered a portion of the blame for rising greenhouse gas (GHG) emissions. However, recent extensive scientific evidence and report by FAO and universities in the US has brought to light the fact that the large GHG emission figure of livestock emission was big data hype. The developed countries play clever by shifting blame for anthropogenic GHG emission away from the fossil fuel based power generation, transportation, industries and lifestyle of the global North to activities in developing countries such as paddy cultivation and animal husbandry.*

Keywords— Livestock, emission, climate change, vulnerability, developed countries, meat, GDP.

Highlights

- World demand for livestock products growing strongly
- vulnerability of livestock increasing in a changing climate
- Increased share of livestock in budgetary allocations, subsidised fodder, availability of water, strengthened veterinary services.

Acknowledgement

This policy brief was supported by PAIRVI, a New Delhi based Human Rights organization. The author likes to thank the Director of PAIRVI, Mr. Ajay Jha, who provided insight and expertise that assisted the paper and comments which greatly improved the manuscript.

I. INTRODUCTION

Evidence from the Intergovernmental Panel on Climate Change (IPCC, 2007) is now over whelming convincing that climate change is real, and it will become worse affecting the poorest and vulnerable people the most (IFAD, 2009). The IPCC predicts that by 2100 the increase in global average surface temperature may be between 1.8 and 4.0 °C. With global average temperature increase of only 1.5 – 2.5°C degrees, approximately 20-30 percent of plant and animal species are expected to be at the risk of extinction (Fischlin et al, 2007). While some species will be able to migrate or change their behavior to accommodate climate change, other species may go extinct (EPA).

Of the planet's 1.3 billion poor people, at least 90% are located in Asia and sub-Saharan Africa (Thornton et al., 2002). The livestock sector in these economies will be specifically affected by climate changes through: changes in the pattern and quantity of rainfall, an increase in temperature, changes in winds, changes in seasonality, more frequent catastrophic events, a decrease in feed and fodder production, reduced water availability, changing patterns and distribution of disease, changes in the marketing and prices of commodities.

Traditionally, however, livestock keepers have been capable of adapting to livelihood threats and indeed—for some people— livestock keeping is itself an adaptation. It is important, however, to recognize that the outcomes of climate change are uncertain and the precise adaptations will vary from location to location and person to person. Strengthening resilience of the livestock sector relies on building the adaptive capacity of livestock keepers and taking an ambitious approach to address the livestock management.

II. LIVESTOCK RESOURCE

India has one of the largest livestock population of around 520.6 million of which cattle (cows , bulls, oxen) constitutes 12.7%, buffalo 56.7%, goats, 14.5% and sheep 5.9 % (FAOSTAT, 2008). India ranks first with respect to the population of buffaloes, second in cattle and goats, third in sheep, fifth in ducks and chickens and tenth in camel population in the world (GOI, 2011-12). The national distribution of livestock and its growth pattern is shown in Table 1.

Table.1: Trends in Livestock Growth

S.No.	Species	Livestock Census (In millions)		Growth Rate (%)
		2003	2007	2003 over 2007
1.	Cattle	185.2	199.1	7.50
2.	Buffalo	97.9	105.3	7.58
3.	Sheep	61.5	71.6	16.41
4.	Goat	124.4	140.5	13.01
5.	Other Animals (Horses, camels, pigs, mules, yak, mithuns)	16.02	13.1	-19.13
	Total Livestock	**485.2**	**529.5**	**9.13**

Source: Compiled by data collected from Livestock Census, DAHD

Significance of livestock for India

Animal Husbandry has been making a significant contribution to the national economy and socio-economic development in the country. In mixed farming systems livestock reduce the risks resulting from seasonal crop failures as they add to the diversification of production and income sources. In rural India, where over 15-20% families are landless and about 80% of the land holders belong to the category of small and marginal farmers, livestock is the main source of livelihood (Hegde, BAIF). The potential of the livestock sector is evident from its economic contribution to the total GDP, which stood at 4.11% at current prices during 2012-13 (MOSPI, 2015). In the arid states like Rajasthan, 8 percent of G.D.P. of the State is contributed by livestock sector alone (Govt of Rajasthan). In the semi arid state of Gujarat, livestock contributes to around 5.08 % of the total SGDP (DOAH, 2013).

In 2010-11, the total output from livestock in India was higher (at Rs 3,40,500 crore) than the value of food grains (Rs 3,15,600 crore) and fruits and vegetables (Rs 2,08,800 crore), and this is going to go up substantially (Mahapatra, 2012). Table 2 shows the livestock sector growth surpassing the other agricultural sub sectors.

Table.2: Growth Trends in Agriculture Sub-Sectors

Sub-Sectors	Ninth Plan 1997-2002	Tenth Plan 2002-2007	Eleventh Plan 2007-2012
Non-Horticulture Crops	1.7	2.1	2.8
Horticulture Crops	3.8	2.6	4.7
Livestock	3.6	3.6	4.8
Fishing	2.7	3.3	3.6

Source: Central Statistical Organisation

To understand the significance of livestock in developing economies we must look beyond GDP and examine the kinds of livestock benefits that are excluded from national accounts. The role of livestock also extends to being an important source of draught power in rural Indian households. Bullock power continues to be used in agricultural operations and transport of agricultural products to nearby markets. Animal energy is renewable, saves fossil fuels, and prevents emission of greenhouse gases. The fossil fuel equivalent of animal energy used in the Indian agriculture has been found to be 19 million tonnes of diesel in 2003 (Birthal & Dikshit, 2010). Considering the same amount of fuel was used to run tractors in the absence of working animal stock, it would have released 6 million tonnes of carbon dioxide (Birthal & Dikshit, 2010).

The dung-manure is another important input contributed by livestock in agriculture. It is estimated that approximately 50% of the total dung produced is utilized as manure while the rest is used as domestic fuel or lays waste on roadside. Above all, livestock contributes to the diet of 1.25 million Indians and many more globally. Milk, meat, and eggs, the "animal-source foods," though expensive, are one of the best sources of high quality protein and micronutrients that are essential for normal development and good health.

In other agro pastoral economies of the world too, value of the contribution from the livestock sector is significantly higher than hitherto believed. While in India, livestock

production currently contributes about 25.6 percent of the agricultural GDP, in Eastern Europe and Central Asian (EECA) countries and Latin America and the Caribbean (LAC) countries, the contribution is as high as 44.5 per cent and at 42.7 percent (Biasca, 2012). If non-monetized contributions (draught power and manure) were to be included, reflecting the importance of integrated crop-livestock farming systems, the contribution of livestock to agricultural GDP would increase further.

Vulnerability of Livestock to Climate Change

Climate change will impact humans and animals both. While humans are more capable of adapting to the impact of climate change, animals are not. When their habitats change irrevocably — the grazing land and water bodies dry up or cool mountains heat up — animals may simply go extinct. Reports have indicated that developing countries are more vulnerable to the effects of climate change due to their high reliance on natural resources, very limited capacity to adapt institutionally and financially, and high poverty levels (Thornton et al., 2006). Animal health in such a habitat may be affected by climate change in four ways: heat related diseases and stress, extreme weather events, adaptation of animal production systems to new environments, and emergence or re-emergence of infectious diseases, especially vector borne diseases that are critically dependent on environmental and climatic conditions

The widespread impact of climate change on livestock in the country is being demonstrated year after year in the form of heavy toll on animal life. Be it the 1999 tropical cyclone that hit the state of Orissa claiming 4.45 lakh livestock or the 2013 floods in Uttarakhand where another 9470 livestock got washed away and 649 cattle shed were damaged, climate change has resulted in livestock losses triggering urgency to respond (MoHA, 2013). Post disaster, crippling shortage of fodder coupled with other hardships forces poor farmers to sell their livestock for peanuts. The people of Kashmir faced a similar plight in 2014 when severe floods in the region claimed life of 10,050 milch animals, besides 33,000 sheep and goats (Firstpost, 2014). Following the calamity, residents of many villages reluctantly sold their livestock at cheap rates to meat sellers since they had no fodder and most cowsheds were either damaged or destroyed.

The unpredictable weather conditions have also resulted in poor availability of pasture and grazing land; and feed and fodder scarcity. In 2003, there was a deficit of 157 million tons of green fodder, 44 million tons of dry fodder, and 25 million tons of concentrates in India (Dijkman et al., 2010*).* The area under permanent pastures and grazing land represents a mere 3.3% of total area and has been declining steadily from 12 million ha in 1981- 82 to 10.2 million ha in 2001-02 (FAI, 1982, 2002).

Besides, the warmer and wetter climate and the densely populated nature of the country in terms of both human beings and livestock has increased the occurrence of vector-borne diseases[1] and spread of zoonotic viral infection (Chogle, Feb 2012*).* According to a study, Ethiopia, Nigeria, and Tanzania in Africa, as well as India in Asia, have the highest zoonotic disease burdens[2](Grace et al., 2012).

Research indicates that there is more in store for the animal as heat stress is predicted to reduce the total milk production for India by 1.6 million tons in 2020 accounting about Rs 23.65 billion, at current price rate. The decline in milk production will be higher in crossbreeds (0.63%) followed by buffalo (0.5%) and indigenous cattle (0.4%) (Upadhayay, 2004-07*).*

Contribution of livestock to climate change

The major greenhouse gases emitted by livestock are methane and nitrous oxide. Livestock mainly emit methane due to anaerobic fermentation in their digestive system while nitrous oxide is released from its manure. These emissions became widely talked about when in 2006 the United Nations concluded that the livestock industry was a big contributor to climate change. The Food and Agriculture Organization (FAO), agency of the United Nations that leads international efforts to defeat hunger, in its report titled 'Livestock's Long Shadow' quantified the emissions from livestock as 18% of the total anthropogenic emissions of the world.[3] Ignoring the contamination and emission by industries and transport, it held livestock business among the 'most damaging sectors' to the earth's increasingly scarce resources, contributing among other things to water and land pollution. However, if the trends in global GHG emissions are considered by sector, it is the electricity/heat that contributes to 37 percent and manufacturing, construction, and industries that contributes to 19 percent of the global GHG emission (TSP dataportal).

Much later after seven years, the 2013 Assessment Report of the FAO, revised figures for livestock emission. It now estimates that the global livestock sector accounts for as much as 7.1 gigatonnes of CO_2-equivalent every year,

[1] Vector–borne diseases are infection transmitted by the bite of infected blood-sucking arthropod species such as mosquitoes, ticks, bugs, and black flies.

[2] Zoonotic diseases are (also called zoonoses) are infectious diseases that can be spread from animals to humans.

[3] Global emission from transport stand at 13% based on 4th Assessment Report of IPCC (2007).

http://dx.doi.org/10.22161/ijeab/2.1.38 *ISSN: 2456-1878*

representing 14.5 percent of all human-related greenhouse gas emissions (Gerber, 2013). Nevertheless, the revised model too calculated livestock sector emission by assessing all sources of emissions along the livestock supply chain. The figures by FAO included not just emission from the animal but the total the amount of greenhouse gases emitted from every aspect of raising meat and dairy. FAO did not do the same when estimating the greenhouse gases from cars (Lutey, 2012). The latter report ignored greenhouse gases actually created during the car's production and instead zeroed in on tailpipe emissions. Besides, it is not livestock per se which are responsible for increased greenhouse gasses; it is the corn/ soybean/ chemical fertilizer/ feedlot/ transportation system under which industrial animals are raised.

Even within the United Nations, there is large discrepancy on global emissions from livestock. In 2013, Food and Agricultural Organization (FAO) of the UN estimated the total global emissions from livestock sector as 14.5 percent (Gerber, 2013). This number was quite low in the 2012 United Nations Environment Programme (UNEP) Report that measured the total emissions from agriculture as 11 percent of which livestock emissions were mere 4.7 percent (UNEP, 2012). Another UK based environmentalist reports that direct emission of methane and nitrous oxide from livestock makes up around 9 percent of total man-made greenhouse-gas emissions. It is emissions from elsewhere in the livestock supply chain, such as transport and feed production, that boosts this figure to 18%. (Kalauher, 2014). Due to large variations in the emissions figures given by different UN agencies and scientists, neither validity nor reliability of the data could be established. Consequently, in the absence of reliable data it is highly undesirable to hold the developing economies accountable for their survival emissions and push them for emission reduction targets equal to the developed countries.

Policy Measures- Combating or contributing to Climate change

The last few decades has seen the Indian livestock sector emerging as one of the fastest growing sub-sectors of agriculture. However, the two entities that have largely been by-passed by the benefits of this growth are the livestock themselves and the small and marginal farmers who rear them. Livestock sector policies and programmes since 1990s has largely been dominated two major development narratives. The first narrative is the productivity myth whereas the second is the efficiency narrative. While both these objectives fast-tracked growth, they did not translate into livestock sector policies, which ensured inclusiveness and efficiency of the sector. Be it the breed development schemes and allied services or market deregulation and privatization, livestock sector policies have largely tended to benefit the already better off livestock holders.

Analyses of major national policies addressing livestock in India reveals that they are apparently biased towards the productivity-enhancement. Priority has been given to those livestock sub-sectors which have showcased huge successes - namely the dairy sector through Operation Flood and the meat industry through the Pink Revolution. Even the very recent National Livestock Policy, 2013, has primarily been formulated to improve productivity of the livestock sector and facilitates dissemination and adoption of technologies for improving efficiency and exploitation of production potential.

Furthermore, the National and various State Action Plans on Climate Change (NAPCC and SAPCC), intended to undertake activities and programmes aimed at climate change adaptation and mitigation, have adopted a very casual approach in dealing with the livestock sector. While a few, like Uttarakhand and Madhya Pradesh, have studied and well documented the climate change impact on livestock and suggested adaptation strategies, rest like Jharkhand and Rajasthan either have excluded the sector from their approach strategy or have dealt more with mitigation measures for reducing livestock methane emission rather than adopting an inclusive approach where support is extended to livestock and its owners. Beside, no assistance has been provided to owners of small ruminants as focus is on bigger milch cattle and higher milk production.

Even the National Mission on Sustainable Agriculture (NMSA), one of the eight missions under NAPCC launched in 2010, proposes extending genetic engineering to livestock. It refuses to learn from the ongoing plight of owners of genetically modified breeds who are more in need of fodder and forage, water, and veterinary aid than owners of local breeds are. It has been observed that some of the traditional Indian breeds of cows like Sahiwal, Tharparkar, Red Sindhi, Rathi, Gir, Kankrej, have traits that enable them to survive under low input, withstand more heat, travel long distances for water, and face resistance to disease.

In the name of better income to livestock owners, the government's ambitious export policies are also adding to climate concerns. With meat production at 6.3 million tons in 2010, India's annual per capita meat consumption stands at only 4 kg while for China, UAE and Australia its 58 kg,74 kg, and 111 kg respectively, thereby making evident where all the meat goes(FAO, 2013). Of the total beef

production in India, the country consumes only 53.8 % while the remaining 46.1% is exported to countries like China (routed through Vietnam), Saudi Arabia, Egypt, Thailand etc., thereby making India the top beef exporting country in the world.[4] In 2010, 36.1 Mt of CO_2-equivalent emissions were related to meat produced in one country but consumed in a different country (The Conversation, 2014)). Therefore, raising livestock, for slaughtering later, comes at a heavy price for India. It includes stresses such as deforestation, desertification, "excretion of polluting nutrients, overuse of freshwater, inefficient use of energy, diverting food for use as feed and emission of GHGs" (Janzen, 2011).

Another emerging problem is the divergence of agricultural land for production of grains for livestock rather than for human beings. Moreover, his produce is not meant to feed domestic cattle but meet the feed demand abroad. Vandana Shiva, Indian environmental activist, says in her book, *Stolen Harvest*, "Europe's intensive livestock economy requires seven times the area of Europe in other countries for the production of cattle feed. In a complementary economy, the cattle eat the straw and agricultural waste that humans cannot. But, in a competitive model such as the livestock industry, grain is diverted from human consumption to the intensive feed for livestock. It takes eight kilograms of grain to produce one kilogram of meat." By using our agri- land for producing feed–grains meant for livestock industry in some foreign land, India is creating a sort of imbalance that will divert grains away from our own people. India, thereby, has 25% deficit in dry fodder, 65% in green fodder and 60% in feed concentrates.

States in India have urged the government to implement immediate measures to tackle the scarcity of fodder in the country. They have pitched for a the creation of a Fodder Corporation of India much in line with the Food Corporation of India(FCI). In face of the 2,00,000 tonnes of deoiled rice bran (DORB) and oil cakes worth Rs 8,500 crore exported every year, state governments have urged the centre to sought a ban on export of oilseed cake and discontinue harvesting of wheat and other fodder crop using combine harvester (Kumar, 2013). This feed could be retained in our livestock feed system to keep feed prices in check.

As meat supply and consumption increase around the world, more sustainable food systems must be encouraged. A study in the UK found that emissions from beef amount to 16 kg CO_2-eq/kg beef compared to 0.8 kg CO_2-eq/kg of wheat (Garnett, 2009). In another study in Sweden, authors conclude that "it is more "climate efficient" to produce protein from vegetable sources than from animal sources", and add that "beef is the least efficient way to produce protein, less efficient than vegetables that are not recognized for their high protein content, such as green beans or carrots" (Carlsson-Kanyama and González 2009).

III. RECOMMENDATIONS

- **Decentralize Policy Planning**: The tendency of the government to centralize planning has remained unchanged and still exercises strong control. Decentralized policy planning actually being practiced is a myth largely; making bureaucracy unable to innovate. Policy implementers face limitations due to hegemonic directives, while at the same time government staff adhering to tacit protocols create resistance to innovative top-down policies and limit engagement with farmers.
- **Increase the Share of Livestock in Budgetary Allocation**: The livestock sector is under-invested and neglected by the financial and extension institutions. Even the 2013-14 budgetary allocation for Animal Husbandry, Dairy Development and Fisheries has been very dismal. While the share for agriculture and allied sector increased by 18 % from 2012 that of Animal Husbandry, Dairy Development, and Fisheries remained low at 12.3% [5](Singh, 2013). Even under the National Mission on Sustainable Agriculture (NMSA), Livestock and Fisheries combined have been allocated 9,000 crores of the total 1,08,000 crore budgetary support to the intervention (NMSA, 2010). Only 6% of the animal heads (excluding poultry) have insurance cover. Livestock extension remains grossly neglected. Only about 5% of the farm households in India have access to information on livestock (GOI, *2012-17*). Improving information and knowledge and then providing training on adaptation-based livestock management at grassroots level is expected to bring about changes that are more significant.
- **Check Excess Promotion Foreign Breeds and Support Local Breeds**: The all-India breeding policy was drawn up under the Third FYP (1961-66) and accepted by the central and state governments (GoI, 1961). The policy emphasised crossbreeding nondescript, indigenous species with exotic stocks to

[4] India produced 3.643 million metric tons of beef in 2012, of which 1.963 million metric tons was consumed domestically and 1.680 million metric tons was exported.

[5] The 2013-14 budgetary allocation for agriculture stands at INR 187.81 billion while the peanut share allotted within it to Animal Husbandry, Dairy Development, and Fisheries is a total of INR 18.17 billion (Singh, 2013).

http://dx.doi.org/10.22161/ijeab/2.1.38 *ISSN: 2456-1878*

increase milk production (Singh, 2011). However, more than three decades of crossbreeding, has revealed that most exotic breeds have not been able to maintain high levels of productivity for a long duration.

- **Make fodder banks or Subsidize Fodder in Drought Periods**: The existing fodder resources of the country can meet 216.62 million out of the 416 million cow units while there is no arrangement to sustain the remaining 48.08 (Kothari & Mishra, DADH**)**. Climate change will further effect livestock production by altering the quantity and quality of feed available for animals. Better quality diets for the ruminants, will increase their feed-conversion efficiencies and thus reduce the amount of methane generated. Fodder storage will also improve food security through construction of larger grain storage facilities.
- **Strategize the Availability of Water for livestock:** Few states that face crippling water crises for both human and animals are Rajasthan, Maharashtra AND Eastern Uttar Pradesh. In this regard, Madhya Pradesh SAPCC strategizes efforts to enhance availability of water for livestock by integrating the concern with watershed management practices. Other states need to follow similar suit strategizing water needs.
- **Create a Disaster Recovery Plan**: Currently, the *gaushalas* are poorly managed with no working arrangements between *gaushalas* and local / state government and Animal Husbandry Department. This makes it essential for the government to provide all support to organizations volunteering to take care of cattle and willing to organise cattle-camps during the natural calamities, such as drought or massive rainfall.
- **Strengthen Veterinary Services:** Climate change may increase the prevalence of parasites and diseases that affect livestock. Improved opportunities for delivering animal health and production services to farmers particularly traditional smallholder farmers is needed in the changing climate scenario. Establishing ambulatory and advisory services at doorstep (as prioritized in Uttarakhand SAPCC) should be made available. On the other hand, indigenous knowledge based on ethno veterinary practices can address some of the health care problems on a local and low-cost basis.
- **Coordinate and Collaborate between Livestock Institutions:** It is a well-known fact that every state in India has a number of organizations for the development of the livestock sector. The state Department of Animal Husbandry (DAH), veterinary colleges and universities, livestock development agencies and milk unions are the most notable among these. Collaboration between these different organisation in the livestock sectors like is critical for betterment of the livestock sector.
- **Strengthen Non-Performing Cooperatives**: The success of dairy cooperatives has been largely confined to a few states in India such as Gujarat, Punjab, Andhra Pradesh and Rajasthan, where brands like Amul, Verka, Vijaya and Saras have become household names. However, a large number of dairy cooperatives, unions and federations are defunct and are not able to create value for their members. Cooperatives in Uttar Pradesh (Parag Dairy), Kerala (Milma), and Madhya Pradesh (Uttam Dairy) are largely loss making (Vivek, 2000*)*. A lot needs to be done to strengthen such non-performing cooperatives. Also, dairy cooperatives need to be promoted and strengthened in hilly and backward districts of the country.
- **Promote Low-Carbon Diet Initiatives:** As far as reducing enteric emission in the country from the large ruminants is concerned, the government must realise that global demand for livestock products is on a rise and this demand in rich countries in many cases is met by imports of livestock products or feed grains from the developing world like India. This practice has made India into exporting 21% of its total meat production, thereby increasing the levels of greenhouse gas emissions in the country (NMPPB, 2008). Methane emissions can be reduced by reducing the number of extra livestock being raised to meet the demands of developed countries and by promoting a low meat diet. The best approach initially can be advertising campaign making people aware that increased livestock production can be severely damaging to their habitats.

IV. CONCLUSION

Livestock are an important and sometimes overlooked element of the livelihood strategies of the poor. With world demand for livestock products continuing to grow strongly across the world and vulnerability of the sector increasing in a changing climate, the developing countries need to strategically plan policies to meet the challenges. This would include measures to strengthen the veterinary service, support local breeds, create a disaster recovery plans, control GHG emission 'transferred' by developed economies, meet the feed deficit, and promote low-carbon diet initiatives. Above all, livestock plays a vital role in the agricultural and rural economies of the developing world

like Africa, Asia and Latin America, where the poor and the landless derive a higher proportion of household income from livestock sources than do other households. Needless to say, developed countries should reconsider holding the developing economies accountable for emissions from agriculture, as their 'lifestyle emission' is no match to the 'survival emissions' of agro-pastoral economies. Blaming them for the comparatively small percentage of global emission they create to provide food security, seems a gimmick/dodge to target a small-time emitter and shrewdly overlook the big one.

REFERENCES

[1] Animal Welfare Board of India (July 2013). Uttarakhand Floods and Relief Measures. Vol 9 Issue 6. MoEF, Govt of India.

[2] Bloomberg News. (16 Jan 2013). *Camel Slaughter Plan Rejected.* Retrieved June 3, 2013 from http://www.bloomberg.com/news/2013-01-16/australian-panel-rejects-plan-to-kill-camels-for-carbon-credits.html

[3] Biasca, Ronalee.(Rev.Sep 2012). The role of livestock for ACP countries: Challenges and opportunities ahead,p7.

[4] Birthal, Pratap S. & Dikshit AK. (July-Dec 2010). Environmental Value of Draught Animals. *Agricultural Economics Research Review, Vol. 23*, pp 227-232.

[5] Chogle, A.R. (Feb 2012). Zoonotic Diseases in India : Focus on Research Options for Anthrax Control. *Journal of the Association of Physician in India, Vol 60.*

[6] Dijkman, Jeroen et al. (2010). Livestock in a changing landscape: Experiences and Regional Perspective, Vol 2, FAO, p 59.

[7] DOAH, 2013. Retrieved on 7 May 2015 from http://doah.gujarat.gov.in/Images/pdf/animalhusbandary/ankdakiy-aheval12-13.pdf

[8] Mitloehner, Frank Dr. (31 March, 2011). Dr. "Debunking"Livestock Long Shadow." Interview. *Drovers Cattle Network News Source*.Retrieved April 29, 2015 from <http://www.cattlenetwork.com/cattle-news/latest/Debunking-livestocks-long-shadow-118996039.html>.

[9] Ehui, S., S. Benin, T. Williams and S. Meijer (2002), Food Security in Sub-Saharan Africa to 2020, Socio-economics and Policy Research Working Paper 49, International Livestock Research Institute, Nairobi

[10] EPA. (Sep 1999). Enteric Fermentation. *U.S. Methane Emissions 1990 – 2020: Inventories, Projections, and Opportunities for Reductions*, p 6-2.

[11] EPA, Adaptation Overview. Retrieved June 3, 2013 from http://www.epa.gov/climatechange/impacts-adaptation/adapt-overview.html

[12] Fischlin et al. (2007). Ecosystems, their properties, goods, and services, Chap 4. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC* (p 213). Cambridge: Cambridge University Press.

[13] FAOSTAT, 2008.

[14] Firstpost (29 Sep2014). 'After floods Jammu and Kashmir to submit memorandum of losses to Centre'. As retrieved on 15 May 2015 from http://www.firstpost.com/politics/floods-jammu-kashmir-submit-memorandum-losses-centre-1735607.html

[15] Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Tempio, G. (2013) Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. Food and Agriculture Organization of the United Nations (FAO), Rome.

[16] Government of Rajasthan. As retrieved on 12 May 2015 from http://animalhusbandry.rajasthan.gov.in/activities.aspx

[17] Hegde, Dr. N.G. Livestock Development for Sustainable Livelihood of Small Farmers, *BAIF*, Pune.

[18] ICAR. Based on calculation of various livestock related schemes under the title Schemes as retrieved on 27 Sep, 2013 from http://www.kiran.nic.in/index.html

[19] IFAD. (Nov 2009). Livestock and climate change. Retrieved on June, 3, 2013 from http://www.ifad.org/lrkm/factsheet/cc.pdf

[20] IPCC. (2007). Fourth Assessment Report.

[21] Janzen, H.H. (2011). What place for livestock on a re-greening earth? *Animal Feed Science and Technology*, pp 166-167, 783-796.

[22] Kalaugher, Liz (14 Nov 2014). Meat is moving Green House Gas Emissions. Retrieved on 1 May 2015 from http://environmentalresearchweb.org/cws/article/news/59290

[23] Kumar, Rahul (9Aug 2013). Export of animal feed deprives our livestock of nourishment, critical to ensure right to food. *The Economic Times.*

[24] Lutey, Tom. (13 Nov 2012). Prof debunks flatulence as major cause of global warming. Retrieved on 29

April 2015 from http://billingsgazette.com/news/state-and-regional/montana/prof-debunks-flatulence-as-major-cause-of-global-warming/article_3340e03d-a03a-5469-ae2d-fa06f23cecb6.html

[25] Mahapatra, Richard. (Feb 2012). Livestock marks shift in agriculture. *Business Standards*. Retrieved June 3, 2013 from http://www.business-standard.com/article/economy-policy/livestock-marksshift-in-agriculture-112020100085_1.html

[26] MOSPI, 2015. Retrieved 7 May 2015 from http://mospi.nic.in/Mospi_New/upload/SYB2015/CH-10-LIVE-STOCK%20AND%20FISHERIES/Livestock_and_fisheries_writeup.pdf

[27] Thornton, P.K., Kruska, R.L., Henninger, N., Kristjanson, P.M., Reid, R.S., Atieno, F., Odero, A. & Ndegwa, T (2002). Mapping poverty and livestock in the developing world. Nairobi, ILRI. Thornton, P.K.,

[28] Thornton, P.K., Jones, P.G., Owiyo, T.M., Kruska, R.L., Herrero, M., Kristjanson, P., Notenbaert, A., Bekele, N., & Omolo, A. (2006). Report of the DFID. *ILRI*, p 200.

[29] TPS data. Retrieved May 13, 2015 from http://www.tsp-data-portal.org/Breakdown-of-GHG-Emissions-by-Sector-and-Gas#tspQvChart

[30] Upadhayay,R.C. (2004-07). Final report of the Network Project on Climate Change. *National Dairy Research Institute*. NDRI

[31] UNEP. (2012). The Emissions Gap Report 2012. United Nations Environment Programme (UNEP), Nairobi, p21.