Technical Research Studies on

"Impacts of Climate Change on Agriculture and Food Security"

i. **Assessment of Climate Change Impacts on livestock production, adaptation and mitigation strategies**

In Collaboration with

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Climate Change and Livestock:
Impacts, Adaptation, and Mitigation

Abstract

Fluctuation in atmospheric temperature and periodic rainfalls patterns is observed throughout world due to industrial revolution and advancements in different fields. Despite the importance of livestock to poor people and the importance of the changes which are in all likelihood to befall livestock systems, the intersection of climate change and livestock in developing countries is distinctly neglected research vicinity. Little bit is known about the interactions of climate and increasing climate variability with other drivers of change in livestock systems and in broader development trends. The present study examined impacts of climate change on livestock systems in Pakistan and evaluated adaptations and feasible interventions for mitigating the sector emissions. The livestock sector is vulnerable to climate change and related policy in two ways. First, livestock production and performance are directly impacted by climate with many projected effects being negative. Second, the sector may need to alter operations to limit the effects of climate change through adaptation and mitigation. Research is needed to better understand the direct and indirect effects of climate change on animal production systems for development of regionally applicable, longer term adaptation strategies.

Introduction

Climate change is arguably the most important environmental issue of our time. With severe and widespread destructive effects, warming of the planet threatens ecological systems, people livelihoods, and species survival. The Earth's surface has been successively warmer over each of the last three decades compared to any preceding decade since 1850. Human activities are responsible for the recent global warming and the marked increase in global atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) to above pre-industrial values. By sector, greenhouse gas pollution originates primarily from industry;

agriculture, forestry and other land use like buildings and transport. Fluctuation in atmospheric temperature and periodic rainfalls patterns referred as CC is observed throughout world due to industrial revolution and advancements in different fields (Saeed 2017).

Human population is expected to increase from 7.2 to 9.6 billion by 2050. This represents a population increase of 33%, but as the global standard of living increases, demand for agricultural products will increase by about 70% in the same period. Meanwhile, total global cultivated land area has not changed since 1991, reflecting increased productivity and intensification efforts. Livestock products are an important agricultural commodity for global food security .There is a growing demand for livestock products, and its rapid growth in developing countries has been deemed the ‘‘livestock revolution”. Livestock are an important protein and calorie source for humans and are an important income source for rural households. Animal productivity can be negatively or positively affected by climate change. In turn, this stimulates adaptive measures like altering management, location, animal numbers, or herd characteristics (Zhang 2017).

Climate change will superimpose itself on these existing tendencies, notably increasing manufacturing hazard and rural vulnerability, mainly in areas that already suffer from continual soil and water aid shortage, high publicity to climatic extremes inclusive of droughts and flooding, poverty and starvation. Climate change pressures will be compounded through a said lack of enough knowledge, infrastructure, company and resources that nearby populations and countrywide governments want to deal with and adapt to climate change. Climate change has threatened agricultural production in maximum components of the sector. High atmospheric temperature adversely affects vegetation, animals and farmers. It reasons aridity and land degradation via decreasing water supply (Ghalib et al. 2017).

Evidence from Intergovernmental Panel on Climate Change (IPCC, 2007) is now overwhelmingly convincing that climate change is real, that it will become worse. While climate change is a global phenomenon, its negative impacts are more severely felt by poor people in developing countries who rely heavily on the natural resource base for their livelihoods. Rural poor communities rely greatly for their survival on agriculture and livestock keeping that are amongst the most climate-sensitive economic sectors (Chiara et al.,2007).

The Fourth Assessment Report (AR4, 2007) of the Intergovernmental Panel on Climate Change also presumes that if anthropogenic activities continue with the same pace, it is anticipated that the global average temperature will rise from 1.1 degree centigrade to 5.5 degree Celsius by 2100 (Babar et al. 2015).

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change describes a clear human influence on climate behavior. This report states that: “Climate change will amplify existing risks and create new risks for natural and humans”. Risks associated with climate change can be due to harsh weather conditions such as severe heat waves, excessive precipitation, and continuous flooding. The intensity of heat waves has increased in large parts of Europe, Asia, and Australia. Similarly, the occurrence of heavy precipitation events has also increased in land (Sabahat & Batool, 2016).

Global demand for livestock products is expected to double by 2050, particularly due to population growth. Meanwhile, climate alternate is a hazard to farm animal’s production due and milk manufacturing, farm animal’s diseases, animal reproduction, and biodiversity. Livestock production might be confined by way of weather variability as animal water consumption is expected to growth by way of three aspects, demand for agricultural lands increase due to need for 70% increase in manufacturing, and food security challenge due to the fact that approximately one-third of the worldwide cereal harvest is used for farm animals feed. Meanwhile, the livestock zone contributes 14.Five% of world greenhouse gas emissions, using in addition climate change. Consequently, the livestock area can be a key participant inside the mitigation of GHG emissions and enhancing international meals protection, improvement inside the worldwide trendy of living (Anthony Yeo 2017).

About 40% of Pakistan population is subjected to disasters with rise in sea level, variation in rainfall pattern ensuing in floods and droughts because of increased temperatures. On global scale decreased precipitation stage and increased surface temperature is the end result of immoderate deforestation, consequently generating predominant international danger to biodiversity and natural ecosystems. Due to deforestation and large use of fuels an increase in CO2 concentration has been mentioned from 280ppm to 380ppm. Among twelve tremendously uncovered nations to CC, Pakistan is also having better diploma of chance to stand the unwell effects of CC (Saeed 2017). Concerns regarding vulnerability to extreme climate conditions should be tackled with solemnity to store Pakistan's agricultural zone and subsequently its economic system. Pakistan’s agriculture has an extensive versatility in its vegetation due to its variable weather in specific components of the united states of America (Saeed 2017).

Because of inertia with both the climate and socio-economic systems upon which greenhouse gas emissions depend, we are bound to face a degree of climate change and its related negative impacts, regardless of the mitigation strategy chosen. However, the sooner the mitigation activities begin, the lower the likely impacts. Nonetheless, adaptation will be needed to protect livelihoods and food security in many developing countries that are expected to be the most vulnerable, even under moderate climate change.

This indicates that the overall challenge of climate policy will be to find the efficient mix of mitigation and adaptation solutions that limit the overall impacts of climate change. This includes recognizing that many mutually re-enforcing synergies exist between specific mitigation and adaptation solutions that can lead to more efficient allocation of "climate response" resources. Importantly, many of these synergies exist in the forestry and agriculture sectors and are of great relevance to rural livelihoods in developing countries(Tubiello 2012).

Despite uncertainties in climate variability, the IPCC Fifth Assessment Report recognized the ''in all likelihood range" of increase in international average surface temperature through 2100, that's among zero.3 _C and 4.8 _C (IPCC, 2013). The potential impact on livestock consist of changes in manufacturing and quality of feed crop and forage, water availability, animal increase and milk production diseases reproduction and biodiversity .These influences are on the whole because of an increase in temperature and atmospheric carbon dioxide (CO_2) concentration, precipitation variant, and a combination of these factors. Temperature impacts maximum of the essential factors for livestock production, consisting of water availability, animal production, duplicate and fitness. Forage quantity and fine are suffering from aggregate of increases in temperature, CO_2 and precipitation version. Livestock diseases are especially affected by increase in temperature and precipitation variant. Climate affect animal agriculture in four ways through the impacts of changes in livestock feed grain availability and price, impact on livestock pasture and forage crop production and quality ,the direct effect of weather and extreme events on animal health ,growth and reproduction and changes in the distribution of livestock diseases and pests(Geijn 1999a). Livestock grazing is generally assumed to negatively affect wildlife, however, a number of studies have found positive impacts as well. We found that livestock change vegetation structure and cover in ways important to small mammals, while ungulates may be affected more by interference competition and changes in forage quantity and quality (Schieltz and Rubenstein, 2016).

Impacts on forage quality and quantity depend on the region and length of growing season. An increase of two degree Celsius will produce negative impact on pasture and livestock manufacturing in arid and semiarid areas and advantageous affects in humid temperate regions. The length of growing season is likewise an essential component for forage first-class and quantity as it determines the length and periods of available forage. A lower in forage quality can increase methane emissions in keeping with unit of gross electricity fed on. Therefore, if forage quality declines, it can want to be offset through lowering forage intake and replacing it with grain to prevent accelerated methane emissions with the aid of livestock (Rojas-downing et al., 2017).

The livestock quarter is often associated with poor environmental affects which includes land degradation, air and water pollutants, and biodiversity destruction. Increases in livestock manufacturing are expected to originate from a declining herbal resource base, for you to motive similarly environmental damage without proper herbal sources control. Base, which will cause further environmental damage without proper natural resources management.

Global agriculture makes use of 70% of fresh water sources, making it the world largest consumer's. However, global water demand is moving toward improved competition because of water shortage and depletion, where 64% of the sector’s population may also stay below water-stressful situations by means of 2025. Water availability troubles will influence the livestock area, which uses water for animal drinking, feed vegetation, and product methods. The livestock region debts for about 8% of worldwide human water use and growth in temperature may growth animal water consumption by factor of two or three. To address this problem, there may be a want to provide crops and lift animals in farm animals systems that demand much less water or in locations with water abundance. As sea level rises, more saltwater will be delivered into coastal freshwater aquifers. Salination provides to chemical and biological contaminants and excessive concentrations of heavy metals already located in water bodies international and can influence livestock manufacturing. Water salination ought to affect animal metabolism, fertility, and digestion. Chemical contaminants and heavy metals should impair cardiovascular, excretory, skeletal, anxious and breathing structures, and impair hygienic fine of manufacturing. There is a loss of studies associated with implications of reduced water availability for land-primarily based livestock systems due to weather exchange (Rojas-downing et al., 2017).

Water scarcity is growing at an increased tempo and impacts among 1 and 2 billion human beings. Climate exchange may have a massive impact on global water availability inside the destiny. Not simplest will this have an effect on farm animals consuming water sources, however it will actually have a pertaining to farm animals feed production structures and pasture yield (Chiara et al., 2007).

The effects of weather exchange on cattle diseases depend on the geographical region, land use type, disease characteristics, and animal susceptibility. The direct effects are related to the increase of temperature, which will increase the potential for morbidity and dying. The indirect effect are associated with the impacts of weather alternate on microbial communities (pathogens or parasites), spreading of vector-borne sicknesses, meals-borne illnesses, host resistance, and feed and water scarcity. Global warming and modifications in precipitation have an effect on the quantity and spread of vector-borne pests together with flies, ticks, and mosquitoes. All animals have a thermal comfort area that is more than a few ambient environmental temperatures which might be beneficial to physiological capabilities. During the day, farm animals preserve a frame temperature inside quite a number ±0.5 degree Celsius. When temperature will increase greater than the top critical temperature of the range, the animals start to go through warmth strain. Animals have evolved a phenotypic response to a single source of pressure inclusive of heat known as acclimation. Acclimation outcomes in decreased feed intake, increased water consumption, and changed physiological functions which include reproductive and efficient efficiency and a trade in respiratory fee .Heat stress on livestock is depending on temperature, humidity, species, genetic ability, life degree, and dietary status. Livestock in higher latitudes could be greater affected by the increase of temperatures than cattle positioned in decrease latitudes, because farm animals in lower latitudes are commonly higher adapted to excessive temperatures and droughts. Confined livestock production systems that have extra manipulate over weather exposure might be much less laid low with weather exchange (Rojas-downing et al., 2017). The list disease related factors that could be affected by Climate Change, which include the molecular biology of pathogens, vectors, zoological factors, farming practices and the status quo of new microenvironments (Zhang 2017).

Biodiversity refers to a variety of genes, organisms, and ecosystems found within a specific environment and contributes to human well-being. Populations that are decreasing in genetic biodiversity are at risk, and one of the direct drivers of this biodiversity loss is climate change (UNEP, 2012). Climate change may eliminate 15% to 37% of all species in the world (Thomas et al., 2004). Temperature increases have affected species reproduction, migration, mortality, and distribution. The Intergovernmental Panel on Climate Change Fifth Assessment Report states that an increase of 2 to 3 degree Celsius above pre-industrial levels may result in 20 to 30% of biodiversity loss of plants and animals (Anthony Yeo 2017).

Agricultural practices along with farm animals manufacturing and management varies around the sector. In order to explain those variability's, the Food and Agricultural Organization of the United Nations and the International Institute for Applied Systems Analysis installed the agro-ecological zones (AEZs) for assessing agricultural resources. These zones are described based on climate, landform, soils, land cowl, and land use. The AEZs are broadly categorized into five categories which include tropics, subtropics, temperate, boreal, and artic. Meanwhile, climate change variability's and impacts on agricultural productions are not always aligned with the AEZs or maybe can be notably distinctive within an AEZ, which makes it tough to generalize the effects of climate exchange on AEZs.Livestock contributes greatly to food security because they are suppliers of global calories, proteins, and essential micronutrients, they are produced in areas that have difficulty growing crops, most of the feed for livestock is not appropriate for human consumption, and they provide manure for crop production. However, there are also concerns that livestock production is detrimental to food security (Anthony Yeo 2017).

Livestock influence climate through land use change, feed production, animal production, manure, and processing and delivery .Feed manufacturing and manure emit CO_2, nitrous oxide (N_2O), and methane (CH_4), which consequently influences climate exchange. Animal production will increase CH_4 emissions. Processing and transport of animal products and land use trade contributes to the growth of CO_2 emissions. The farm animal's area is regularly associated with negative environmental influences together with land degradation, air and water pollution, and biodiversity destruction. Increases in farm animal's production are predicted to originate from a declining herbal aid base, in an effort to cause similarly environmental damage without proper natural resources management.

Emissions from livestock production contribute more GHG to the ecosystem than the entire international transportation region. The livestock area contributes directly and indirectly to GHG emissions, such as through animal body structure, animal housing, manure storage, manure treatments, land software, and chemical fertilizers. Direct emissions from animal resources consist of enteric fermentation, respiratory, and excretions. Indirect emissions refers to emissions derived from feed plants, manure utility, farm operations, cattle merchandise processing, transportation, and land use allocation for cattle manufacturing like Deforestation, desertification, carbon released from cultivated soils.

The livestock sector's contribution of total anthropogenic GHG emissions was evaluated by a global livestock environmental assessment model (GLEAM). GLEAM performs an analysis of the emissions of global livestock production along supply chains. The main elements of the livestock supply chains that are analyzed by GLEAM are: herd, feed, manure, animals' energy requirement, feed intake, production, and emissions, allocation of the total emissions at the physical farm boundaries to co-products and services emission per kg of product and post-farm gate emissions like transport and processing. GLEAM also considers land use change as the conversion of forest to pasture or arable land for crops(Anthony Yeo 2017).

Forests and herbal habitats have been steadily converted to pasture and cropland since 1850s. Agriculture lands cover approximately 38.5% of global general land vicinity, which consists of 28.Four% arable land and sixty eight.4% everlasting meadows and pasture. Pasturelands have improved with the aid of issue of six considering the fact that 1800, now covering 35 million km^2. Profit per unit of land refers back to the willingness of farmers to manage a selected land. The growing demand for cattle merchandise has notably changed the natural panorama. Land degradation is the deterioration of bodily, chemical, and organic properties of soil. Land degradation has been diagnosed as one of the drivers of land conversion from woodland to croplands and pastures because manufacturers exhaust their soil assets and as a result search for more appropriate land. Land use exchange influences the herbal carbon cycle, which consequently releases excessive quantities of carbon into the ecosystem, increasing GHG emissions. Furthermore, pasturelands include extra carbon than croplands. Climate trade also substantially affect many natural habitat and placed many species at higher hazard of extinction inside the coming century (Henderson and Reinert, 2018).

Livestock manure releases CH_4 and N_2O gas. The decomposition of the organic materials found in manure under anaerobic conditions releases methane. Liquid manure found in lagoons or holding tanks releases more methane than dry manure. Manure methane emissions are a function of air temperature, moisture, pH, storage time, and animal diet estimated global methane emissions from manure decomposition of 17.5 million tons of CH_4 per year. Pig manure comprises almost half of global manure-related methane emissions. At the country level, China has the highest global methane manure-related emissions, primarily due to pig manure.N^2O emissions from manure storage are dependent on environmental conditions, handling systems, and duration of waste management. Manure must be handled aerobically and then anaerobically to release N_2O emissions, which is more likely to occur in dry waste-handling systems. They reported that N_2O emissions from stored manure are equivalent to 10 million tons N per year (Anthony Yeo 2017).

Manure handling with associated mitigation practices encompass decreasing the publicity of manure to water (e.g. dry scraping in preference to washing right into a pond) and converting control from anaerobic to aerobic situations. One additional mitigation approach for manure-related non-CO_2 emissions is to regulate diets, for the reason that GHG contents of manure is weight loss program dependent. Specifically, the ration composition and feed additives can have an effect on the amount of N in urine and feces and the quantity of fermentable natural remember in feces, consequently ensuing in changes in manure-based CH_4 emissions. For example, in dairy cattle sectors, lipid supplementation reduces enteric CH_4 emissions however increases N_2O emissions (Zhang 2017).

Livestock grazing affects over 60% of the world's agricultural lands and can influence rangeland environment offerings and the amount and first-class of wildlife habitat, resulting in modifications in biodiversity. Concomitantly, livestock grazing has the potential to be unfavorable to a few natural world species at the same time as benefiting other rangeland organisms. Many imperiled grouse species require rangeland landscapes that show off diverse flowers structure and composition to complete their lifestyles cycle. However, because of declining populations and reduced distributions, grouse are increasingly more becoming a global conservation challenge. Grouse, as a suite of upland recreation birds, are regularly considered an umbrella species for different natural world and accordingly used as indicators of rangeland fitness. With a projected increase in call for cattle merchandise, better information could be required to mitigate the anthropogenic outcomes of cattle grazing on rangeland biodiversity (Dettenmaier et al., 2017).

Increasing atmospheric concentrations of CO_2 and other greenhouse gases are increasing air temperatures and altering precipitation patterns globally, including in the Northern Hemisphere, with consequent impacts on agricultural systems. Pastureland and rangeland ecosystems, so important worldwide for the goods and services they produce and the cultures they support, are certain to be significantly affected by climate change and rising.

Many aspects of the ecology of rangelands are determined by the spatial and temporal distribution of precipitation and its effects on soil water availability. Rising CO_2, warming, and altered precipitation patterns will all impact soil water content and plant water relations, so understanding their combined effects on the functioning of rangeland ecosystems is essential (Izaurralde et al. 2011).

The differential response among species to warming suggests there may be strong selection pressures that will alter rangeland community structure in response to further warming. These changes will potentially impact associated trophic levels that depend on these plant communities for important stages in their life cycles. Drought stress during the growing cycle may reduce the influence of warming on the rate of plant development. The phonological response of herbaceous plants to rising CO_2 will vary among species. The implications of rising temperature and CO_2 for the phonologies of rangeland plants are not well understood or quantified. Thus, temperature is the primary climate driver that will determine growing season length and plant phenology, but precipitation variability and CO_2 may cause deviations from the overall patterns expected from temperature alone (Izaurralde et al. 2011).

Adaptation is a process by which an animal or plant species becomes fitted to its environment. It is the result of natural selection's acting upon heritable variation. Even the simpler organisms must be adapted in a different ways like their structure, physiology, and genetics, in their locomotion or dispersal, in their means of defense and attack, in their reproduction and development, and in other respects. Adaptation strategies can improve the resilience of crop and livestock productivity to climate change. Mitigation measures could significantly reduce the impact of livestock on climate change. Adaptation and mitigation can make significant impacts if they become part of national and regional policies (Anthony Yeo 2017). Adaptation measures involve production and management system modifications, breeding strategies, institutional and policy changes, science and technology advances, and changing farmers' perception and adaptive capacity. Research is needed on assessments for implementing these adaptation measures and tailoring them based on location and livestock system. This could be accomplished with GIS and remote sensing technologies applicable at broad and local scales.

Adaptations in field-based livestock include additional care to continuously match stock rates with pasture production, altered rotation of pastures, modification of times of grazing, and timing of reproduction, alteration of forage and animal species, altered integration within mixed livestock/crop systems including using adapted forage crops, reassessing fertilizer applications, care to ensure adequate water supplies, and use of supplementary feeds and concentrates. It is important to note, however, that there are often limitations to these adaptations; for example, more heat-tolerant livestock breeds often have lower levels of productivity. In intensive livestock industries, there may be reduced need for winter housing and for feed concentrates in cold climates, whereas in warmer climates there might be increased need for management and infrastructure to ameliorate heat-stress related reductions in productivity, fertility, and increased mortality. Furthermore, the capacity to implement infrastructural adaptations could be low in many tropical regions, whereas in the midlatitude, the risk of reduction in water availability for agriculture may limit adaptations that use water for cooling (Geijn 1999b).

Diversification of livestock and crop varieties can increase drought and heat wave tolerance, and may increase livestock production when animals are exposed to temperature and precipitation stresses. In Addition, this diversity of crops and livestock animals is effective in fighting against climate change related diseases and pest outbreaks. Agroforestry as a land management approach can help maintain the balance between agricultural production, environmental protection and carbon sequestration to Offset emissions from the sector. Agroforestry may increase productivity and improve quality of air, soil, and water, biodiversity, pests and diseases and improves nutrient cycling. Changes in mixed crop-Livestock systems are an adaptation measure that could improve food security. This type of agricultural System is already in practice in two-thirds of world, producing more than half of the milk, meat, and crops such as cereal, rice and sorghum(Anthony Yeo 2017).

Changes in breeding strategies can help animals increase their tolerance to warmness pressure and Illnesses and improve their reproduction and growth improvement. Therefore, the mission is in growing Livestock manufacturing whilst keeping the precious adaptations presented through breeding techniques, All of which would require additional studies. In addition, coverage measures that enhance adaptive Capability by using Facilitating implementation of edition techniques will be critical. For instance, growing

International gene banks may want to enhance breeding programs and serve as an coverage policy, which Include has been achieved for flowers with the In-Trust plant collections in the CGIAR gene banks. This Could be a first-rate Breakthrough that calls for considerable investment and international collaboration To be successful. One of the limiting elements for these changes to succeed is the disposition and Capability Of farmers to recognize the trouble and adopt climate trade version and mitigation measures. Because of this, it is vital to collect statistics about farmers' perceptions to mitigation and adaptation Measures. One method for gathering records approximately farmers' perceptions that has been used for Mitigation and Adaptation studies is qualitative the usage of open-ended survey questions or institution Dialogue at Workshops to understand individual and group evaluations. By information farmers' Perceptions and Along with them in rural policy development, there's a more risk of engaging in food protection and environmental Conservation goals (Anthony Yeo 2017).

Changes in mixed crop-livestock systems can enhance performance via generating more meals on much less land the use of fewer sources, which includes water. Improving feeding practices as an edition measure may want to not directly enhance the performance of livestock manufacturing. Some of the cautioned feeding practices include, change of diets composition, converting feeding time and/or frequency, incorporating agroforestry species inside the animal food regimen and education manufacturers in production and conservation of feed for distinctive agro-ecological zones (IFAD, 2010).Shifting places of farm animals and crop manufacturing could lessen soil erosion and enhance moisture and nutrient retention. Another adaptive measure may be adjusting crop rotations and converting timing of management operations like grazing, planting, spraying, irrigating. This measure may be tailored to changes in period of developing seasons, warmth waves and precipitation variability.

Actions to limit damage from climate change need to be implemented now in order to be effective. Mitigation actions involve direct reduction of anthropogenic emissions or enhancement of carbon sinks that are necessary for limiting long-term climate damage. Adaptation is necessary to limit potential risks of the unavoidable residual climate change now and in coming decades. Importantly, there are significant differences in the policy nature underlying adaptation and mitigation actions. The benefits of adaptation choices will be realized almost immediately but will matter most under moderate climate change, perhaps up to about mid-century. By contrast, benefits of mitigation may only be realized decades from now, becoming relevant towards the end of the century(Tubiello 2012).

Mortimore and Adams for Northern Nigeria mentioned elements of adaptation for Allocating farm labor across the season in ways that follow unpredictable intra-season rainfall variations negotiating the rain, making use of biodiversity in cultivated crops and wild plants, Increasing integration of livestock into farming systems at a cost of increased labor demands(Morton 2007).

Several recent studies on Northern Kenya and Southern Ethiopia reviewed by Morton have focused on the coping strategies used by pastoralists during recent droughts and the longer-term adaptations are as the pastoralists also use supplementary feed for livestock, purchased or lopped from trees, as a coping strategy, they intensify animal disease management through indigenous and scientific techniques, and they increasingly pay for water from powered boreholes. Livelihood diversification away from pastoralism in this region predominantly takes the form of shifts into low-income or environmentally unsustainable occupations such as charcoal production, rather than an adaptive strategy to reduce ex-ante vulnerability. There are a number of intercommunity mechanisms, to distribute both livestock products and the use of live animals to the destitute, but these appear to be breaking down due to high levels of covariate risk within communities(Morton 2007).

In Australia, adoption of management changes for longer term adaptation is currently limited by uncertainty in climate change science, uncertainty in the impacts of climate change, and limited

Information on the best response strategies for profitable farming enterprises. Research is needed to better understand the direct and indirect effects of climate change on animal production systems for development of regionally applicable, longer term adaptation strategies. For livestock industries there is a specific and urgent need for greater understanding of how. The biology like behavioral, immunological, physiological, and metabolic functions) of animals will be affected by the direct effects of climate change, and greater understanding of the indirect effects on disease/parasite exposure and feed quality through effects on plant and soil systems. Our understanding of the impact of climate change on the feed base is more advanced, and new models, such as mosaic agriculture, are emerging that will increase the resilience of livestock farming across Australia. Whole farm systems modelling needs to shift from modelling climate change impacts for current plants, animals, and management practices, to evaluating adaptation options as identified by the researchers and agro-ecosystem managers who would develop and implement those options(A et al. 2012).

A study conducted in Zimbabwe which describes 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. 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 are more extensive in the sandy soil zone. This results in the deterioration of veld condition in clay soils earlier than in sandy zones hence livestock in clay zones being affected first(Risk and Centre 2012).

Pakistan has experienced the worst drought of its history in the last decade of the last millennium which lasted under 2004. The climate change is affecting the animal productivity especially in resource poor localities in the region. Pakistan still suffers more than 30 % Crude Protein and TDN deficiency for large and small ruminants in its feed balance. The exact Information on the losses are very much undermined and not realized by many or sometimes sorely lacking. A detailed understanding is warranted to anticipate the future impacts of the climate change in different areas on the productivity of the ruminants. Unless these losses are realized and scientifically proved, the measures needed or taken will attain less significance.

The studies revealed that there is a drastic effect on temperature change on water buffaloes and their calves. When ambient temperature reached to 32-47º C with a mean relative humidity of 33-75%,

the physiological norms of the buffalo calves were significantly affected and their weekly body weight decreased as 43 kg as compared to 46 kg under open air tree shade than inside a shed with showers plus ceiling fans, body temperature was higher 101.6ºF that 101.0ºF, respiration rate was higher 28 to 26 per minute, and the pulse rate increased to 53-54 per minute under treatment with open air tree shade as compared to inside with ceiling fans and showers. It will delineate in length some of the effects on livestock production due to climate change in a country like Pakistan where 35-40 million rural people derive their livelihood from livestock rearing.

The countries like Pakistan require change in policies regarding the livestock production. Keeping in view the effects of climate change, the production systems in the country need to be re-visited and revolutionized. There is no best way than managing the dairy animals in a wise and economical way during the hot summers enabling them to dissipate their body heat and facilitating the animals comfort as much as possible. Correct management decisions will enable the dairy animals to grow faster, pronounced estrual behavior, improved conception rates, reproduce on time and produce their maximum when they are wet. The measures like prediction of monsoon, protection from rain and sun, feeding management like grazing during cool hours, offering succulent varieties, decreased DMI, use of silage and hay, nutrient density, avoiding excess with normal rumen function, provision of fresh and clean water, genetic selection, housing management like tunnel ventilation, sprinkling, showering, misting, use of ecological modeling and innovations with appropriate strategic management decisions, risk analyses and devising some innovative methods to provide comfort to the animals can help in minimizing the effect of heat stress on dairy animals(Younas and Ishaq 2014).

The research study regarding to Impact of Climate Change on Livestock Composition in Pothwar Region, Pakistan. It was planned to assess the impact of climate change on livestock composition during 2014, in Pothwar region of Pakistan. Data regarding this experiment were collected through questionnaire by queering 61 respondents. Paired t-test was used to check the difference between livestock composition in present and before 10 years. The results showed that paired sample t-test of livestock in which difference values for mean, standard deviation and standard error of mean for cattle are -0.525, 1.840 and 0.236, respectively, having T-value, equal to 2.23 and p-value, equal to 0.03, which is significant at 1%. Similarly, buffalo group indicated difference in values of mean, standard deviation and standard error of mean -0.607, 2.193 and 0.281, respectively. The paired T-statistic also shows significant difference with t-value, p-value less than 0.05, which show significance level. Likewise goat group pointed out difference values of mean, standard deviation and standard error of mean are -0.836, 2.544 and 0.326 respectively that comprises p-value equal to 0.01, which is significant at 1%. The results of percent change in livestock composition prove that percent change in policy needs to be devised by taking into consideration the food and energy security of the country. It should be done in a consultative manner in which all the relevant stakeholders are taken on board(Naheed et al. 2015).

Country level assessment of feed supply and demand for livestock in Pakistan was conducted for the year 2013.Availability of feed ingredients was calculated from the official crop production statistics using published harvest index and extraction ratios, and their nutrient supply was estimated from local feed composition tables. Feed requirements of livestock species were calculated from the standard tables published by US National Research Council. The results showed that indigenous feed resources were short for livestock and poultry requirements. The supply and demand gap for dry biomass, crude protein (CP) and metabolizable energy were 19.4%, 37.2% and 38.0%, respectively. Crop residues were the predominant source comprising 58.8% of the total feed supply, while fodder and grazing shared 23.8% and 9.2%, respectively. Grains and by-products contributed 8.2% to the feed supply. In attempt to fill this gap, large quantities of oilseed meals were imported mainly for the poultry sector. Maize was the major feed grain used in poultry and ruminant rations, and they together consumed 79% of the country's total maize produce. Based on the anticipated rapid expansion in poultry, dairy and feedlot farming in Pakistan, the feed gap will further enlarge and this warrants future focus on efficient and intensive utilization of the local conventional and nonconventional feed resources. The data and information provided a sound basis for regular updating in future to attain sustainable growth of livestock sector in the country. The future expansion in livestock, dairy and poultry industries in Pakistan would impose further pressure on country's feed resource base. There should therefore be policy decisions on the way forward to meet the future feed supply challenges that the anticipated expansion in livestock, dairy and poultry industries in Pakistan would impose for sustainable livestock production(Habib et al. 2016).

Livestock farming is an integral part of rural smallholders and has a vast untapped potential for productivity increase and income generation. Small farmers and landless livestock producers derive around 10–25 percent of their incomes from this sub-sector. There have been and, largely, still are two primary purposes of raising livestock the first one is to meet the dietary needs of the rural and urban populace for milk and meat consumption and other is to fulfill the work performance requirements of the farm. Large Ruminants receive more attention because of their capacity to perform both of the above functions. About 50 percent of the red meat supply in the country comes from large ruminants, yet beef production is not considered a separate specialized production activity. Rather it is treated as a by-product from animals kept for dairying and draught purposes. Most breeds of the large ruminants in Pakistan are famous for either milk production or draught power with hardly any beef breed. Therefore, the entire livestock production system revolves around milk production activity.

A rapidly growing economy, higher per capita incomes and rising population are the determinants of increase in the demand for livestock products which exerts a continuous pressure on the country's livestock resource base. In Pakistan, the increase in animal products has mainly been the result of an increase in animal numbers, not productivity per animal. However, improved animal efficiency will be an imperative necessity for future increase in food production. One popular hypothesis often discussed is that our national livestock herd consists of a substantial number of unproductive and low productive animals that claim their share in feeding and management leaving less for the more productive stock. This, in turn, decreases national averages of milk and meat production. Secondly, the composition of the national herd is also not economical and appropriate in several ways. This means that our national herd with its present level of per animal productivity is unable to meet the rising demand for livestock products. The purpose of study is to develop a model herd structure using the milk. Production efficiency criteria and compare our national herd with the model to identify gaps in livestock production, research, and development(Ahmad 2014a).

This described a simple quantitative framework for livestock development planning. Specifically, it provides a useful tool for use in typical planning situation-the estimation of livestock resources required for meeting specified production targets. By doing so, we can estimate the required number of total as well as in-milk livestock that would be sufficient to achieve the given level of production target. An analysis of the yield gap in milk production has been made. The yield gap is estimated in two scenarios. Firstly, if the production potential achievable at research stations for each breed is extrapolated for all in-milk animals of the breed, the milk production thus achieved is the Yield Gap-1. The gap comes

Equivalent to about 50 percent of the present milk production. The second scenario is developed with a hypothesis that the maximum milk production potential is still much higher, which is depicted in the elite herds that are usually maintained at research stations or at private livestock farms. Yield Gap-2 comes equivalent to about 100 percent of the present milk production. The composition of the national livestock herd is also analyzed by considering the two scenarios of the yield gaps. Under Scenario I, the required number of animals in each category were less to the tune of 5.9 million buffaloes and 6.4 million cows(Ahmad 2014a).

The study was conducted to document the ethno veterinary medicinal (EVM) practices for the treatment of different parasitic diseases of livestock in Cholistan desert, Pakistan. An initial reconnaissance survey among the local shepherds was conducted to identify the traditional healers. Information was collected from the traditional healers using a well-structured questionnaire through open-ended interviews and guided dialogue technique. The parasitic diseases reported in livestock were tick and lice infestation, mange, myiasis and helminthiasis. A total of 77 ethno veterinary practices comprising of 49 based on plant usage and 28 based on dairy products, chemicals and other organic matter were documented. A total of 18 plant species representing 14 families were documented to treat the parasitic diseases. The treatments and practices reported, however, need to be validated in order to identify those which can be of practical advantage in agricultural development. Issues that should be addressed are efficacy, quality, safety and standardization of doses. It appears from the information provided by the respondents that the plants used in EVM in Cholistan are rapidly disappearing due to overgrazing, overexploitation and long spells of droughts. Therefore, there is also a need to carry out studies on abundance and distribution of plant species of medicinal value as well as the harvesting intensities in the study area(Farooq et al. 2008).

Mitigation measures will also be suggested to save productivity losses to ensure the food supply from animal origin for the exploding population. There is potential to reduce livestock sector GHG emissions through the implementation of different technologies and practices. However, they are not widely used. Some of the technical options for mitigating the impact of livestock on climate change are carbon sequestration, improving diets to reduce enteric fermentation, improving manure management, and more efficient use of fertilizers. Mitigation measures need public policy support to be effective.

Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. In order for mitigation to be effective we need to take action now before the next disaster to reduce human and financial consequences later by analyzing risk, reducing risk, and insuring against risk.

Carbon sequestration can be achieved through decreasing deforestation rates, reversing of deforestation by replanting, targeting for higher-yielding crops with better climate change adapted varieties, and improvement of land and water management A beef sector study performed in Brazil estimated a reduction of up to 25% of GHG emissions related to grazing land use and land use change, accomplished by improving animal and herd efficiency. Soil organic carbon can be restored in cultivated soils through conservation tillage, erosion reduction, soil acidity management, double-cropping, crop rotations, higher crop residues, mulching and more. Improving pasture management can also lead to carbon sequestration by incorporating trees, improving plant species, legume inter seeding, introducing earthworms, and fertilization. In addition, grass productivity and soil carbon sequestration could be improved by increasing grazing pressure in grasslands that have a lower amount of grazing animals than the livestock carrying capacity. Improving grazing land management could sequester around 0.15 gigatonnes CO2-eq yr_1 globally.

Enteric fermentation is a source of methane emissions that can be reduced through practices such as improvement of animal nutrition and genetics. Examples of practices for mitigating enteric fermentation are increasing dietary fat content providing higher quality forage increasing protein content, providing supplements and the use of Antimethanogen. However, there is high uncertainty in the efficacy of these practices because various studies have demonstrated that the initial reductions of enteric fermentation achieved are only temporary .A one percent increase of dietary fat can decrease enteric methane emissions between 4 to 5%. However, rumens need to limit fat content to 8% of dry matter to avoid a decrease in livestock performance. Providing higher quality forage also results in a reduction of methane emissions because it increases digestibility. An increase of protein content of feed can also improve digestibility and reduce overall methane emissions per unit of product. Providing supplements, such as feed antibiotics, which tend to increase weight gain and reduce feed intake per metric ton of meat produced, can reduce enteric fermentation. In the case of milk, bovine somatotropin (a bovine growth hormone) increases production. An increase in milk production leads to less animals needed to produce the same amount of milk and less emissions produced. Antimethanogen vaccines are another practice that directly reduces methane emissions in the rumen. However, this is a new technology with limited research on emission reduction efficiency and animal health.

Fertilizer application on animal feed crops increases nitrous oxide emissions. Therefore, mitigation measures such as increasing nitrogen use efficiency, plant breeding and genetic modifications, using organic fertilizers , regular soil testing, using technologically advanced fertilizers, and combining legumes with grasses in pasture areas may decrease GHG emissions in feed production. Nitrogen use efficiency can be improved by applying the required amount that the crop will absorb and when it needs the nutrients, and placing it where the plant can easily reach it. Regular soil testing can be a part of a nutrient management plan depending on the region and crop, and improve efficiency of nitrogen use. Plant breeding and genetic modifications can reduce the use of fertilizers by increasing a crop's nitrogen uptake.

Most methane emissions from manure management are related to storage and anaerobic treatment.

Although manure deposited on pasture can produce nitrous oxide emissions, the mitigation measures are often difficult to apply because of the manure dispersion on pasture. Therefore, most mitigation practices involve shortening storage duration, improving timing and application of manure, used of anaerobic digesters, covering the storage, using a solids separator, and changing the animal diets. Anaerobic digestion can reduce methane emissions while producing biogas. Anaerobic digesters are lagoons or tanks that maintain manure under anaerobic conditions to capture biogas and combust it for producing energy or flaring(Anthony Yeo 2017).

Unmitigated climate change will, in the long term, exceed the capacity of natural and human systems to adapt. Given the magnitude of the challenge to reduce GHG concentrations in the atmosphere, it is

Imperative to receive the contribution of all sectors with significant mitigation potential. Agriculture is recognized as a sector with such potential, and farmers, herders, ranchers and other land users could and should be part of the solution. Therefore, it is important to identify mitigation measures that are easy to implement and cost effective in order to strengthen the capacity of local actors to adapt to climate change. The livestock production system contributes to global climate change directly through the production of GHG emissions and indirectly through the destruction of biodiversity, the degradation of land, and water and air pollution. There are three main sources of GHG emissions in the livestock production system: the enteric fermentation of animals, manure and production of feed and forage.

Indirect sources of GHGs from livestock systems are mainly attributable to changes in land use and

Deforestation to create pasture land. For example, in the Amazon rainforest, 70 per cent of deforestation has taken place to create grazing land for livestock. In general, smallholder livestock systems have a smaller ecological footprint16 than large-scale industrialized livestock operations. Mitigation of GHG emissions in the livestock sector can be achieved through various activities, including:

• Different animal feeding management.

• Manure management (collection, storage, spreading).

• Management of feed crop production.

Convention on Climate Change (UNFCCC) held in Paris in December 2015, more than 100 countries indicated that they would reduce agricultural GHG emissions as part of the global effort to keep warming to a maximum of 2°C. Emissions from ruminant livestock present a particular challenge as enteric CH_4 emissions alone comprise ~40% of total agricultural emissions. Estimating emissions from animal agriculture can be done through simple estimates, generically available data on animal populations and regional-level fixed emission factors per animal. But these estimates are subject to very large uncertainties and their appropriateness for estimating emissions at the country level is questionable. More appropriate country-specific methods can be developed using local data and expert opinion in the first instance, even in the absence of country-specific emission factors. Reducing GHG emissions from ruminant livestock is challenging technically even if livestock production is constant, and is particularly challenging if the sector is increasing in size. Internationally the quantity of GHG produced per unit of product has been declining consistently and for both cattle meat and milk than 50 years ago. This decline is largely due to increased efficiency of production. Increasing efficiency is therefore a key component of agricultural GHG mitigation. Increasing efficiency, while essential, may not be enough on its own. New technologies are therefore needed and for ruminant livestock there are some promising products; compounds that inhibit enteric CH_4, vaccines, low emitting sheep have been successfully bred and, a variety of low emitting feeds, and feed additives(Clark 2016).

The study examined baseline emissions of greenhouse gases from ruminant livestock in Pakistan for the year 2014 and evaluated feasible interventions for mitigating the sector emissions. Total emissions as CO_2-equivalents from livestock supply chain from cradle to farm gate were estimated at 431 007 * 10^3t.

Major part of the emissions was produced by the mixed system and the remaining was contributed by the grazing system. Bulk of milk (87.6%) and meat (59.4%) was produced by the mixed system, which was associated with three-fold higher emissions at 332 248 *10^3 t than when they were produced by the grazing system. The emission intensity of milk and meat averaged 183.4 and 443.2 respectively, and ranked higher than the global average values. Buffaloes were responsible for the major proportion of emissions, followed by cattle.

A cradle to farm gate life-cycle assessment of ruminant livestock supply chain in grassland and mixed systems of Pakistan for the Year 2014 was performed. The 'global livestock environmental assessment model' developed by FAO was used. This model quantifies GHG emissions arising from production of the main livestock commodities such as milk and meat from cattle, buffalo, sheep and goat in different production systems. The GHG emissions are expressed in mass-based CO2-equivalents. The main agricultural GHG are specified as carbon dioxide, nitrous oxide and methane. The model calculates gross production of milk and meat and emission intensities of commodities by animal species. Three farm-compatible interventions were individually evaluated for their potential of mitigating GHG and the impact

On milk yield in dairy cow and buffalo in the grazing and mixed systems. Fodder improvement, health improvement, breed improvement and combination of all the three as a package were evaluated against the baseline scenario. A large proportion of enteric CH4 as part of the digestion process is caused by poor-quality feed of low digestibility. In the present case, fodder supply was inadequate and crop residues constituted about half of the rations for dairy and nondairy animals in the mixed system. Consequently, the DM digestibility of average rations was low (<54%).(Habib et al. 2016) reported that the poor feed resource base of Pakistan was mainly composed of crop residues (59%), with limited contributions from cultivated fodders (24%), grazing (9%) and agro-industrial by-products (8%). Animals in the grazing system mostly depend on poor quality native-rangeland vegetation which has DM digestibility of up to 45%. Emissions of a large amount of enteric CH4 are a constant feature of such poor feeding regime. The large emissions from enteric fermentation offer an opportunity for mitigation and emissions could be effectively reduced with improved feeding(Habib 2017).

The mitigation options investigated were related to the dairy sector and were selected on the basis of common national consensus expressed on various technical forums and identified as more relevant for significant improvements in productivity, and were included in the national development plan for increasing livestock production. Additional criteria used for selecting the options were their feasibility for adoption by farmers and their potential to reduce emission intensities. Shortage of fodder is one of the major constraints affecting productivity and there are large gaps between per-acre fodder yields obtained by farmers and those achieved in research stations with improved technology in Pakistan.

In the present study, a two-fold increase in the yield of the three most common fodder crops, namely berseem, maize and sorghum, resulting from improved technology on the same land, was assumed as a target intervention for its effect on milk yield and emission intensity in dairy cows and buffaloes.

Genetic improvement is the most important pillar of increasing productivity in livestock. Poor access of rural smallholders to desired breeding services in Pakistan has reduced the number of improved genotypes and most of the current dairy population of cattle and buffalo features delayed puberty, long calving intervals, a shorter lactation cycle and low milk yield. Impact of breed improvement through selective breeding or cross-breeding is achieved in the form of reduction in the number of replacement breeding animals, improvements in fertility and age at first calving, less wastage from involuntary culling and empty reproductive cycles, coupled with increased milk production. Evaluation of various mitigation interventions indicated that there are significant opportunities for growth on a low-carbon path for the dairy sector in the country. The present study has provided, for the first time, a detailed assessment of emissions from livestock supply chain from cradle to farm gate in Pakistan and the findings would serve as baseline information for further research and policy debate(Habib 2017).

Changed feeding practices offer what, at first sight, are a relatively straight forward mitigation approach. These can include the feeding of tannin containing plants, sapponins, high lipid diets, high cereal diets, and feeds with high sugar concentrations. The evidence base for the short term efficacy of most of these approaches is reasonably secure although there is less evidence for their longer term efficacy. A bigger issue is perhaps their practicality and affordability. Lipids for example have been found to reduce emissions by about 5% for every 1% point increase but unless high lipid by-products are available there is likely to be a cost barrier to their increased use. In addition, there is a fine line between reducing emissions and adversely affecting the ruminants' digestive system. Tannins suffer similar problems; they may consistently reduce methane emissions but they can adversely affect feed intake and are often agronomical poor. The inclusion of cereals at high levels is a well proven methane mitigation route although emissions from growing the cereal crop need to be taken into account; the economics may also be unfavorable in many situations and feeding cereals is impractical for free-ranging animals.

Modifying rumen processes to bring about substantial reductions in CH4 emissions is not new and the testing of halogenated compounds, such as chloroform, was carried out 50 years ago. More modern approaches have targeted the identification of more benign compounds that specifically target the micro-organisms (methanogens) responsible for producing CH4 in the rumen. It reported the successful testing of one such compound 3-nitrooxy propanol (3NOP) which reduced emissions from lactating dairy cows by ~30% and had a positive benefit for live weight gain. The economics and practicality of using such compounds, in particular the mode of delivery, will need to be confirmed but the development of a compound that brings about a substantial reduction in emissions, is animal friendly and appears to have a productivity benefit is a major breakthrough. Researchers in New Zealand and Australia have also been working on stimulating the ruminants' own immune system to produce antibodies that can suppress the activity of methanogens(Clark 2016).

It contributes to the expanding literature by adding an empirical evidence that livestock play an important role in risk control. The analysis is based on three-year data of agricultural households from the Punjab Province of Pakistan. The study area is well irrigated and famous for the rapid adoption of high-yielding varieties of wheat in the late 1960s and the early 1970s. Nevertheless, yield risk on individual farms is not negligible. Price risk also affects agricultural households since most of them market their products through private channels. During the 1980s, Pakistan witnessed a shift toward livestock products in the composition of value added in agriculture. This suggests that the shift within a farm had improved household welfare through a reduction in income variability.

The analysis used three-year household data on production and consumption from the rice-wheat zone of the Punjab Province, where most agricultural households combine livestock keeping and crop cultivation within a farm. Decomposition of per capita income into deterministic and transient portions showed that livestock holding contributes to a reduction in income variability through the negative correlation of livestock income with crop income and throughdecumulation of livestock assets contingent on a realized income in the crop sector.

It would suggest that the rises in the share of the livestock subsector in agricultural value added in Pakistan should have improved the welfare position of households with substantial livestock holding. Since smaller farms have a relatively larger livestock herd in the Pakistan Punjab, the recent phenomenon might have had an equity-improving effect as well. Furthermore, because livestock have an additional welfare value as an effective insurance measure, the farmers might have had a stronger incentive to accumulate livestock than those who maximize expected profit from agriculture. In other words, the seemingly large size of livestock holding from the criterion of profit-maximizing efficiency might be rational and efficient for a poor, risk-averse household(KUROSAKI 1995).

There are possible mitigation strategies for livestock. Given that feed production accounts for about 47% of livestock emissions it is a key target for mitigation. However, there are a number of welfare concerns with some of the current proposals to reduce emissions using feed alterations. One strategy for mitigating methane emissions with feed changes is by including more concentrates in addition to, or in place of, a proportion of dietary forage. Although emissions per animal may rise as productivity improves, there is generally a reduction in the greenhouse gases released on a per kg-product produced basis. In intensive production systems, grain feeding of livestock often entails removing cattle raised for beef from pastures to provide the finishing ration in a feedlot. This is a common system in the United States and is being emulated in other parts of the world, such as Latin of roughage in feedlot diets, with an already observed reduction from 29% in 2009 to 21% in 2011. In Brazil, the practice of finishing cattle in feedlots increased 50% from 2003 to 2010. In cattle feeding systems with high ratios of concentrate to forages, digestive problems are common.

The starches in this concentrated diet are quickly digested and fermentation acids can build up disrupting the normal function of the rumen. Abnormal rumen function and digestive disorders can lead to acidosis, bloat, and if persistent, liver abscesses, and even the foot disorder laminitis. Maintaining normal rumen function on these diets is a constant challenge for the feedlot industry; one quarter of cattle mortality in feedlots can be attributed to digestive disorders America.

Feed additives can be used to inhibit CH_4 production in a variety of species. However, some dietary additives that are being tested have potential animal health concerns. For example, in vitro studies have shown that fumarate can work as an alternative to CH_4 as a sink for H_2 in the rumen, but feeding fumarate in its free acid form can lower rumen pH and inhibit fiber digestion, while feeding it in salt form can induce toxicity. Effective doses may well exceed current dietary recommendations. Especially in low protein diets, nitrates are also potential CH_4 mitigation agents. However, the intermediate product from nitrate metabolism, nitrite, is toxic, and so feeding it requires a gradual acclimation to a high dietary intake in order to avoid nitrite toxicity. Another proposed supplement, sulfate, has been linked to sulphur-induced polioencephalomalacia, a condition in US feedlot cattle associated with excessive production of H_2S in the rumen from diets high in distillers grains co-products from the ethanol industry, which are high in sulfate. The FAO cautions that more research is needed. Mitigation strategies should steer clear of feeding substances that might endanger the animals, either outright or in the absence of highly skilled management.

In general, as animals become more productive, greater feed intake is needed to support the energy

Requirements associated with growth or lactation, but the proportion of total energy requirements

Required for maintenance decreases. Thus the feed input per unit of product produced is reduced.

Further, with increases in productivity, fewer animals are needed to reach a given level of output.

In the climate change mitigation literature, this concept is often exemplified with dairy cows. Swine and poultry produce relatively small amounts of enteric CH_4, but their manure can be a significant source of GHG production. Therefore, maintaining or improving feed conversion efficiency in these species, and subsequently reducing the volume of manure produced for a given level of output, is considered a major strategy for mitigating CH_4 and N_2O. However, there is evidence across species that overemphasis on productivity in genetic selection can lead to unintended negative effects on animal welfare(Shields and Orme-evans 2015).

Individual ruminant animals differ in the amount of methane they produce when fed the same quantity Of feed and this trait has been found to be heritable. In addition, some animals eat less but achieve the

Same level of productivity and so will produce less CH_4 because of the strong link between intake and

CH_4. The former approach has been adopted as a direct way of reducing emissions, while the latter is

Being studied from a productivity and efficiency perspective with a strong CH_4 co-benefit. In New

Zealand, contrasting high and low CH_4 selection lines have been developed with the difference in

Methane per unit of intake being just under 10%. Animal productivity has not been affected. The CH_4

Implications of selecting for reduced intake is less well documented but it is a highly attractive route

Since the primary aim is an increase in productivity. Since continuous improvement in performance via

Animal breeding is well accepted and highly cost effective the animal breeding route is highly.

Attractive. However, it may not come at a zero cost. Breeding low emitting animals may reduce the

Progress in other economically important traits and even though breeding for reduced intake is

Focused on increased profitability the costs of breeding for the trait can be substantial(Clark 2016).

One of the major objectives has been to review the growth performance of Pakistan's livestock sub-sector. While the long term growth rate of livestock production has been good, it has exhibited considerable variation from product to product and period to period. Poultry production exhibited high growth rates until 1984-85.They turned negative during 1994-95 to 1997-98. Also, there was hardly any growth in beef production in the latter period. Improved feed that could contribute significantly to dairy and poultry production, remains limited. Progress in livestock subsector has been mainly the result of growing number of animals rather than rising productivity per animal.

The analysis underlines the importance of technology in the livestock sub-sector especially the use of artificial insemination. For this purpose all necessary infrastructure especially refrigeration must be placed at the disposal of insemination centers which need to be widely spread throughout the country side. Secondly, livestock holders must be provided with adequate incentives by ensuring a fair share in consumer prices not only to induce them to adopt the latest technologies but also to reward their efforts. Livestock extension services can be particularly helpful in convincing the farmers to adopt modern husbandry practices. By way of ensuring fair prices to farmers, animal sales, on live-weight basis, as in the case of poultry, should be encouraged in livestock markets. Thirdly, most of the livestock feed markets are still in their infancy and suffer from inadequate competition. They are typically characterized by monopoly positions of one kind or another and lack any quality control. There may thus be the need to ensure adequate supply of quality and balanced animal feed through imposition of penalties for illicit trade practices. Finally, the low productivity of animals can also be attributed to widespread incidence of animal diseases and lack of animal husbandry services apart from poor feed quality. The provision of these services to each and every corner of the rural areas is an absolute need(Ahmad 2014b).

Climate change will affect livestock production and consequently food security. Livestock production will be negatively impacted, especially in arid and semiarid regions. In addition, climate change will affect the nutritional content of livestock products, which are one of the suppliers of global calories, proteins and essential micronutrients. Conversely, livestock production also influences climate change. Deforestation due to expansion of pasturelands and croplands for livestock production contributes 9.2% of total livestock GHG emissions .However, the feed production stage contributes the greatest fraction (almost half) of GHG emissions across the complete livestock production process. It is expected that this stage will further increase its contribution due to intensification of livestock production. Meanwhile, enteric fermentation is the largest GHG contributor in the animal production stage. Therefore, if livestock numbers continue to increase and feeding practices are not changed, global emissions due to livestock production will continue to increase. Climate change adaptation, mitigation practices, and policy frameworks are critical to protect livestock production. Among the reviewed studies, diversification of livestock animals using different crop varieties, and shifting to mixed crop-livestock systems seem to be the most promising adaptation measures. By diversifying animal and crop varieties, the tolerance to climate variability like drought, heat waves and to diseases and pest outbreaks will be improved. In addition, shifting to mixed crop-livestock systems can improve efficiency by increasing production with the use of fewer resources.

On the mitigation side, improvement of animal nutrition and genetics are important because enteric fermentation is a major GHG emitter in livestock production. However, the efficacy of these practices in reducing emissions is uncertain and more research is needed concerning effective mitigation practices related to enteric fermentation. If we want effective adaptation and mitigation measures to address climate change and livestock production, these measures should be scaled up through policy. For example, understanding farmers' perceptions and including them in policy development can improve food security and environmental conservation by promoting widespread practice adoption. In addition, a comprehensive view of costs, time, and effort required from the producer needs to be included to the policy framework to maintain sustainable production systems.

The Global Livestock Environmental Assessment Model (GLEAM) was developed to address the need for a comprehensive tool to assess interactions between livestock and the environment. GLEAM is a process-based model based on a Life Cycle Assessment (LCA) framework. It covers 11 main livestock commodities at global scale, namely meat and milk from cattle, sheep, goats and buffalo; meat from pigs; and meat and eggs from chickens. The model runs in a Geographic Information System (GIS) environment and provides spatially disaggregated estimates on greenhouse gas (GHG) emissions and commodity production by production system, thereby enabling the calculation of the emission intensity for any combination of commodity and farming systems at different spatial scales. The highest spatial resolution considered by the model is defined by squared cells of approximately 10 km x 10 km at the equator. Each cell represents a portion of the earth and has an attribute value associated with it, such as crop yields or animal numbers, being the smallest unit of information in the GIS environment. GLEAM is built on six modules reproducing main steps of livestock supply chain: the herd module, the feed ration and intake module, the animal emissions module, the manure module, the feed emissions module and the allocation module.

The model uses a classification of farming systems based on the feed use and agro-ecological conditions. GLEAM distinguishes three farming systems for cattle (grazing, mixed and feedlot), two for other ruminant species (grazing and mixed), three for pigs (backyard, intermediate and industrial) and three for chicken (backyard, layers and broilers). Three agro-ecological zones are considered: temperate -which includes temperate regions and tropical highlands, arid -including arid and semi-arid tropics and subtropics, and humid -comprising humid and sub-humid tropics. Overall, this amounts to over 9,000 discrete supply chains, defined as unique combinations of commodity, country, farming system and climatic conditions.

The herd module is about the animals themselves and describes: the herd structure and the characteristics of the animals. To allow an accurate accounting of production, natural resource use and GHG emissions (including the use of IPCC (2006) Tier 2 methodology), GLEAM considers different on animal types, weights, phases of production and feeding situations. The manure module describes how manure is managed and simulates the rate at which excreted nutrients are applied to feed crops. The calculation is based on the total amount of excreted nutrients in each cell (using Tier 2 excretion rates), the proportion of nutrients lost during manure management and the area of arable/grass land in the cell to determine the rate of application per hectare. The feed module calculates the composition of the ration for each species, production system and location, the nutritional values of the ration and the impact associated with it such as land-use and GHG emissions. The determination of the ration is done separately for ruminants (cattle, buffalo, sheep and goats) and for monogastrics (pigs and chickens).

Total GHG emissions from national livestock and poultry sector of Pakistan for the year 2014 were estimated from cradle to farm gate using the downloadable version-2 of Global Livestock Environmental Assessment Model (GLEAM-i 2016) developed by FAO. The system boundary of cradle to farm gate encompasses all backend processes in livestock and poultry production chain up to the farm gate where the animals or products leave the farm and include production and supply of farm inputs and on-farm production activities. The model estimate main sources of emissions such as carbon dioxide (CO2), nitrous oxide (N2O) and methane (CH4) from feed production to enteric methane, manure emissions and embedded energy. The emissions are expressed in mass based CO2- equivalents. The model calculates emission per unit of commodity protein referred as emission intensity. It considers typology of farming system. In case of ruminant livestock emissions from grazing system and mixed systems are assessed and for poultry the systems are differentiated into backyard and commercial broiler and layers.

Primary data on country's animal numbers for the year 2014 were estimated from the inter-census growth of livestock during 1996 and 2006. The data on herd structure, distribution of animals between the grazing and mixed production systems, feed resources and feeding practices were extracted from the country report. Data on reproduction parameters, per animal milk yield, body weight, mortality and ration composition were obtained from various national reports and literature and further verified through consultation with local subject experts. The assessment does not include land use change related to pasture expansion because of non-availability of local specific data. All milk was converted to fat and protein corrected milk (FPCM) with 4.0% fat and 3.3%

protein, using the following formula (FAO 2010);

FPCM kg = (raw milk kg × (0.337 + 0.116 × fat contents%+ 0.06 × protein contents %).

For investigating potential of mitigation options, three interventions pertaining to feed, health and breed were selected and evaluated individually and in combination as a package in dairy cows and buffaloes. Data and information on the impact of selected interventions on productive, reproductive and health performance of dairy animals were extracted from literature, reports and through personal communication with the local experts. Separate calculations on GLEAM were performed for the baseline scenario and then for each mitigation intervention. Carbon footprint of milk and meat and changes in their yield were compared to the baseline scenario. The criteria used for selecting interventions included the potential for improving production efficiency, feasibility of adoption by local farmers and the potential to reduce total GHG and enteric methane emission intensities under current farm condition in the country(Habib and Ahmad 2018).

Future challenges for livestock sector

Global demand for livestock products is expected to double by 2050, particularly due to development within the global general standard of living. Meanwhile, climate alternate is a hazard to farm animal's production due to the effect on quality of feed crop and forage, water availability, animal and milk manufacturing, farm animal's diseases, animal reproduction, and biodiversity. Livestock production might be confined by way of weather variability as animal water consumption is expected to growth by way of three aspects, demand for agricultural lands increase due to need for 70% increase in manufacturing, and food security challenge due to the fact that approximately one-third of the worldwide cereal harvest is used for farm animals feed. Meanwhile, the livestock zone contributes 14% of world greenhouse gas emissions causing climate change (Yeo 2017).

The future expansion in livestock, dairy and poultry industries in Pakistan would impose further pressure on country's feed resource base. There should therefore be policy decisions on the way forward to meet the future feed supply challenges that the anticipated expansion in livestock, dairy and poultry industries in Pakistan would impose for sustainable livestock production (Habib et al. 2016).

The overall challenge of climate policy will be to find the efficient mix of mitigation and adaptation solutions that limit the overall impacts of climate change. This includes recognizing that many mutually re-enforcing synergies exist between specific mitigation and adaptation solutions that can lead to more efficient allocation of "climate response" resources. Importantly, many of these synergies exist in the forestry and agriculture sectors and are of great relevance to rural livelihoods in developing countries (Tubiello 2012).

Impacts

- The Intergovernmental Panel on Climate Change Fifth Assessment Report states that an increase of 2 to 3^{o}C above pre-industrial levels may result in 20 to 30% of biodiversity loss of plants and animals (Yeo 2017). This will produce negative impact on pasture and livestock manufacturing in arid and semiarid areas and advantageous affects in humid temperate regions (Rojas-downing et al. 2017).
- Climate affect animal agriculture in four ways through the impacts of changes in livestock feed grain availability and price, impact on livestock pasture and forage crop production and quality, the direct effect of weather and extreme events on animal health ,growth and reproduction and changes in the distribution of livestock diseases and pests (Geijn 1999). Forage quantity and fine are suffering from aggregate of increases in temperature, CO_2 and precipitation version.
- The studies revealed that there is a drastic effect of temperature change on water buffaloes and their calves. When ambient temperature reached to 32-47^{o} C with a mean relative humidity of 33-75%, the physiological norms of the buffalo calves were significantly affected and their weekly body weight decreased as 43 kg as compared to 46 kg under open air tree shade than inside a shed with showers plus ceiling fans, body temperature was higher 101.6^{o}F that 101.0^{o}F, respiration rate was higher 28 to 26 per minute, and the pulse rate increased to 53-54 per minute under treatment with open air tree shade as compared to inside with ceiling fans and showers.

- The birth rate of livestock was also heavily affected by the drought. High rates of distortion also occurred during the drought period in Zimbabwe. The effect of drought on livestock varies across ecological zones. 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. This results in the deterioration of yield condition in clay soils earlier than in sandy zones hence livestock in clay zones being affected first (Risk and Centre 2012).
- Global water demand is moving toward improved competition because of water shortage and depletion, 64% of the sector's population may stay below water-stressful situations by means of 2025. Climate exchange may have a massive impact on global water availability and shortage in water will ultimately influence the livestock area, which uses water for animal drinking, farm animals feed production structures and pasture yield and product methods (Chiara Calvosa, Delgerma Chuluunbaatar 2007).
- Water salination ought to affect animal metabolism, fertility, and digestion. Chemical contaminants and heavy metals should impair cardiovascular, excretory, skeletal, anxious and breathing structures, and impair hygienic fine of manufacturing. There is a loss of studies associated with implications of reduced water availability for land-primarily based livestock systems due to weather exchange (Rojas-downing et al. 2017).
- There are effects of weather exchange on cattle diseases depend on the geographical region, land use type, disease characteristics, and animal susceptibility. The direct effects are related to the increase of temperature, which will increase the potential for morbidity and dying. The indirect effect are associated with the impacts of weather alternate on microbial communities (pathogens or parasites), spreading of vector-borne sicknesses, meals-borne illnesses, host resistance, and feed and water scarcity.
- Global warming and modifications in precipitation have an effect on the quantity and spread of vector-borne pests together with flies, ticks, and mosquitoes. All animals have a thermal comfort area that is more than a few ambient environmental temperatures which might be beneficial to physiological capabilities. During the day, farm animals preserve a frame temperature inside quite a number ±0.5 degree Celsius. When temperature will increase greater than the top critical temperature of the range, the animals start to go through warmth strain.

- Heat stress on livestock is depending on temperature, humidity, species, genetic ability, life degree, and dietary status. Livestock in higher latitudes could be greater affected by the increase of temperatures than cattle positioned in decrease latitudes, because farm animals in lower latitudes are commonly higher adapted to excessive temperatures and droughts (Rojas-downing et al. 2017). The list disease related factors that could be affected by Climate Change, which include the molecular biology of pathogens, vectors, zoological factors, farming practices and the status quo of new microenvironments(Zhang 2017).
- Many aspects of the ecology of rangelands are determined by the spatial and temporal distribution of precipitation and its effects on soil water availability. Rising CO2, warming, and altered precipitation patterns will all impact soil water content and plant water relations, so understanding their combined effects on the functioning of rangeland ecosystems is essential (Izaurralde et al. 2011). The implications of rising temperature and CO2 for the phonologies of rangeland plants are not well understood or quantified. Thus, temperature is the primary climate driver that will determine growing season length and plant phenology, but precipitation variability and CO_2 may cause deviations from the overall patterns expected from temperature alone (Izaurralde et al. 2011).

Adaptation options

- Adaptation is necessary to limit potential risks of the unavoidable residual climate change now and in coming decades. Importantly, there are significant differences in the policy nature underlying adaptation and mitigation actions. The benefits of adaptation choices will be realized almost immediately but will matter most under moderate climate change, perhaps up to about mid-century. By contrast, benefits of mitigation may only be realized decades from now, becoming relevant towards the end of the century (Turbiello 2012).
- Adaptation strategies can improve the resilience of crop and livestock productivity to climate change. Adaptation is a process by which an animal or plant species becomes fitted to its environment. It is the result of natural selection's acting upon heritable variation. Even the simpler organisms must be adapted in a different ways like their structure, physiology, and genetics, in their locomotion or dispersal, in their means of defense and attack, in their reproduction and development, and in other respects.

- Adaptations in field-based livestock include additional care to continuously match stock rates with pasture production, altered rotation of pastures, modification of times of grazing, and timing of reproduction, alteration of forage and animal species, altered integration within mixed livestock/crop systems including using adapted forage crops, reassessing fertilizer applications, care to ensure adequate water supplies, and use of supplementary feeds and concentrates. It is important to note, however, that there are often limitations to these adaptations; for example, more heat-tolerant livestock breeds often have lower levels of productivity. In intensive livestock industries, there may be reduced need for winter housing and for feed concentrates in cold climates, whereas in warmer climates there might be increased need for management and infrastructure to ameliorate heat-stress related reductions in productivity, fertility, and increased mortality. Furthermore, the capacity to implement infrastructural adaptations could be low in many tropical regions, whereas in the midlatitude, the risk of reduction in water availability for agriculture may limit adaptations that use water for cooling(Geijn 1999b).
- Among the reviewed studies, diversification of livestock animals using different crop varieties, and shifting to mixed crop-livestock systems seem to be the most promising adaptation measures. By diversifying animal and crop varieties, the tolerance to climate variability like drought, heat waves and to diseases and pest outbreaks will be improved. In addition, shifting to mixed crop-livestock systems can improve efficiency by increasing production with the use of fewer resources.
- It is better to manage the dairy animals in a wise and economical way during the hot summers enabling them to dissipate their body heat and facilitating the animals comfort as much as possible. The measures like prediction of monsoon, protection from rain and sun, feeding management like grazing during cool hours, offering succulent varieties, decreased DMI, use of silage and hay, nutrient density, avoiding excess with normal rumen function, provision of fresh and clean water, genetic selection, housing management like tunnel ventilation, sprinkling, showering, misting, use of ecological modeling and innovations with appropriate strategic management decisions, risk analyses and devising some innovative methods to provide comfort to the animals can help in minimizing the effect of heat stress on dairy animals (Younas and Ishaq 2014).

- Agroforestry may increase productivity and improve quality of air, soil, and water, biodiversity, pests and diseases and improves nutrient cycling. Changes in mixed crop-livestock systems are an adaptation measure that could improve food security. This type of agricultural system is already in practice in two-thirds of world, producing more than half of the milk, meat, and crops such as cereal, rice and sorghum. Changes in breeding strategies can help animals increase their tolerance to warmness pressure and Illnesses and improve their reproduction and growth improvement (Anthony Yeo 2017).
- Changes in mixed crop-livestock systems can enhance performance via generating more meals on much less land the use of fewer sources, which includes water. Improving feeding practices as an edition measure may want to not directly enhance the performance of livestock manufacturing. Some of the cautioned feeding practices include, change of diets composition, converting feeding time and/or frequency, incorporating agroforestry species inside the animal food regimen and education manufacturers in production and conservation of feed for distinctive agro-ecological zones (IFAD, 2010).
- Shifting places of farm animals and crop manufacturing could lessen soil erosion and enhance moisture and nutrient retention. Another adaptive measure may be adjusting crop rotations and converting timing of management operations like grazing, planting, spraying, irrigating. This measure may be tailored to changes in period of developing seasons, warmth waves and precipitation variability.
- The low productivity of animals can also be attributed to widespread incidence of animal diseases and lack of animal husbandry services apart from poor feed quality (Ahmad 2014). Livestock extension services can be particularly helpful in convincing the farmers to adopt modern husbandry practices. By way of ensuring fair prices to farmers, animal sales, on live-weight basis, as in the case of poultry, should be encouraged in livestock markets. Thirdly, most of the livestock feed markets are still in their infancy and suffer from inadequate competition. They are typically characterized by monopoly positions of one kind or another and lack any quality control. There may thus be a need to ensure adequate supply of quality and balanced animal feed.
- Several recent studies on Northern Kenya and Southern Ethiopia highlighted the coping strategies used by pastoralists during recent droughts, e.g. they use supplementary feed for

livestock, purchased or lopped from trees, intensify animal disease management through indigenous and scientific techniques (Morton 2007).

Mitigation

- Mitigation measures have to be adopted to save productivity losses to ensure the food supply from animal origin for the exploding population. Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. In order for mitigation to be effective we need to take action now before the next disaster to reduce human and financial consequences later by analyzing risk, reducing risk, and insuring against risk.
- Improvement of animal nutrition and genetics are important because enteric fermentation is a major GHG emitter in livestock production. However, the efficacy of these practices in reducing emissions is uncertain and more research is needed concerning effective mitigation practices related to enteric fermentation.
- A beef sector study performed in Brazil estimated a reduction of up to 25% of GHG emissions related to grazing land use and land use change, accomplished by improving animal and herd efficiency. Improving pasture management can lead to carbon sequestration by incorporating trees, improving plant species, legume inter seeding, introducing earthworms, and fertilization. In addition, grass productivity and soil carbon sequestration could be improved by increasing grazing pressure in grasslands that have a lower amount of grazing animals than the livestock carrying capacity. Improving grazing land management could sequester around 0.15 gigatonnes CO2-eq yr_1 globally.
- Mitigation of GHG emissions in the livestock sector can be achieved through activities like different animal feeding management; Manure management (collection, storage, spreading), and Management of feed crop production.
- Changed feeding practices offer a relatively straight forward mitigation approach. These can include the feeding of tannin containing plants, sapponins, high lipid diets, high cereal diets, and feeds with high sugar concentrations. A bigger issue is perhaps their practicality and affordability. Lipids for example have been found to reduce emissions by about 5% for every 1% point increase but unless high lipid by-products are available there is likely to be a cost

barrier to their increased use. In addition, there is a fine line between reducing emissions and adversely affecting the ruminants' digestive system. Mitigation strategies should steer clear of feeding substances that might endanger the animals, either outright or in the absence of highly skilled management.

Conclusion

Climate change adaptation, mitigation practices, and policy frameworks are critical to protect livestock production. Diversification of livestock and crop varieties can increase drought and heat wave tolerance, and may increase livestock production when animals are exposed to temperature and precipitation stresses. In addition, this diversity of crops and livestock animals is effective in fighting against climate change related diseases and pest outbreaks. There are three main sources of GHG emissions in the livestock production system: the enteric fermentation of animals, manure and production of feed and forage. There are indirect sources of GHGs from livestock systems, which are mainly attributed to changes in land use and deforestation to create pasture land. In order to scale up effective adaptation and mitigation measures to address climate change and livestock production, then se measures should be scaled up through policy. For example, understanding farmers' perceptions and including them in policy development can improve food security and environmental conservation by promoting widespread practice adoption. Future research is needed to understand the behavioral, immunological, physiological, and metabolic functions of animals affected by the direct effects of climate change. Also research focus should be given on exploring indirect impacts on factors like feed quality, plant health and soil systems, beside disease/parasite exposure. A detail understanding is warranted to anticipate the future impacts of climate change on productivity of the ruminants. Unless these losses are realized and scientifically proved, the measures needed or taken will attain less significance.

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