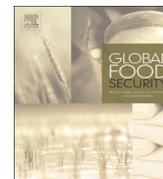




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# Climate change through a gendered lens: Examining livestock holder food security



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## ABSTRACT

Livestock holders experience increased food insecurity because of climate change. We argue that development programs, public health specialists, and practitioners must critically examine gendered impacts of climate change to improve food security of livestock producers. This review illustrates the differential experiences of men and women and how vulnerability, adaptive capacity, exposure and sensitivity to climatic stimuli are gendered in distinct ways between and among livestock holding communities. We propose a gendered conceptual framework for understanding the impact of climate change on food security among livestock holders, which highlights potential pathways of vulnerability and points of intervention to consider in global health strategies for improving household food security.

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## 1. Introduction

Climate change is a socioeconomic and environmental problem that receives attention for its impact on global food security. Climate-change related risks to livestock-based livelihoods include decreases in crop yields and crop failure, livestock loss, increased water scarcity, and destruction of other productive assets (see [FAO, 2008](#)). This paper focuses on the nexus of gender, livestock production, and food security.

Livestock systems are rapidly changing. Dynamic parts of the agricultural economy, especially in developing nations where demand for animal products continues to increase. Globally, more than 60 percent of rural households keep livestock ([FAO, 2009a](#)); smallholder livestock production in many developing countries provides income, food, fuel, building materials, draft power, and fertilizer for the general population. As with other smallholder

agricultural systems, livestock contributions to sustainable livelihoods, food security, and nutrition have become increasingly unpredictable with accelerations in climate change ([Morton, 2007](#)). Much like crop and aquaculture systems, livestock systems are subject to risk from instability in weather and damage from extreme events such as heat stress, drought, and flooding ([Jones and Thornton, 2009](#)). There is limited research into the direct effects of climate change across diverse livestock production systems, despite similarities in smallholder livelihoods and productivity risks.

Extensive research on gender, in regards to food security or climate change, suggests that pre-existing social stratifications exacerbate the negative impacts of climate change on food security ([Weiler et al., 2014](#)). The relative dearth of research on how climate change influences dynamics between livestock production, gender relations, and food security calls for conceptual frameworks to improve our understanding of the mechanisms underlying effective adaptations. This review examines how gender influences climate related vulnerability of food security among livestock holders. By applying a gendered lens to an existing framework, we link climate change to food security and highlight gendered pathways of vulnerability. By identifying key points of

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intersection between gender and vulnerability, practitioners can use the framework to promote appropriate climate change adaptation activities in international research and development initiatives.

## 2. Application of cross-cutting terms and conceptualizing relationships

We provide working definitions for the following terms to facilitate cross-disciplinary use and application of this conceptual framework.

- **Adaptation:** Adjustment or preparation of natural/ human systems to a new/changing environment in order to moderate harm or exploit beneficial opportunities (EPA, 2013).
- **Climate change:** Significant changes in the measures of climate lasting for an extended period of time, including temperature, precipitation, or wind patterns that occur over several decades or longer in a given geographic area (EPA, 2013).
- **Gender:** The socially constructed norms, roles, and behaviors for men and women in a society. Gender determines social expectations for men and women, as well as access to resources. This is distinct from the concept of sex, which refers to the biological and physiological characteristics (WHO, 2013).
- **Livestock:** Any domestic or domesticated animal–bovine (including buffalo and bison), ovine, porcine, caprine, equine, poultry and bees raised for food or in the production of food. Does not include wild animals captured from hunting or fishing (FAO, 2001).
- **Livestock Holder:** A member of a community that incorporates livestock rearing as a necessary component to their livelihood. We use this concept broadly to include pastoral populations, farming and communities who own and manage livestock.
- **Malnutrition:** A broad term for nutritional status that includes both under-nutrition and over-nutrition. Under-nutrition stems from inadequate calories, protein, or micronutrients for growth and maintenance or inability to fully utilize nutrients. Over-nutrition stems from excess calories, and nutrients beyond what the body requires for normal growth and metabolism (UNICEF, 2009).
- **Mitigation:** Intervention to reduce human impact on the climate system, encompasses strategies to reduce greenhouse gas emissions and sources, and enhance greenhouse gas sinks (EPA, 2013).
- **Pastoralism:** Livelihood strategy that derives more than half of household income from livestock and livestock products.
- **Resiliency:** The capability to anticipate, prepare for, respond to, and recover from multi-hazard threats with minimum damage to social well-being, the economy, and the environment (EPA, 2013).
- **Urban Livestock Agriculture:** Livelihood based on raising animals for food and other uses (e.g., selling at markets) within and around cities (de Bon et al., 2010).
- **Vulnerability:** The degree that systems (e.g., households, communities, and organizations) are susceptible to loss, damage, suffering and death in the event of a 'natural' hazard or disaster (Adger, 2006).

## 3. Food security

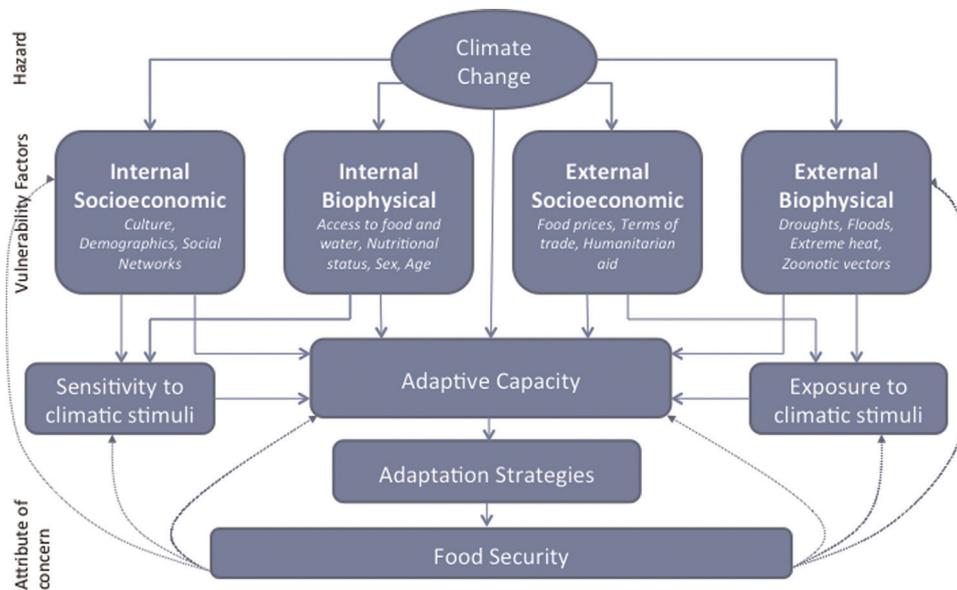
There are three hierarchical dimensions which must be assured in achieving food security: nutritious and culturally appropriate food must be available, accessible, and consumed. The well-

established threat of climate change to food security may disrupt any one of these dimensions (Schmidhuber and Tubiello, 2007). Drought and flooding associated with changes in rainfall patterns may reduce agricultural production, limiting the *availability* of food. Climate variations can contribute to the spread of infectious diseases in livestock, compromising their health and limiting the safety and *availability* of animal products for food. Increased frequency and severity of extreme events affect fodder and water availability for livestock, and reduce *access* to food for people who rely on market exchange of animal products for grains (Battisti and Naylor, 2009). Researchers and practitioners often disregard the final dimension of food security—consumption—in climate change discussions despite links between climate-related environmental change and issues central to consumption. The time women allocate to household labor is associated with both climate change and choices about childcare and has a direct effect on household nutrition. A woman with increased demands on her time may spend less time breastfeeding or initiate complementary feeding at an earlier age, consequently reducing *consumption* of appropriate food by younger children. Even when food is available, accessible, and consumed, climate change may affect the nutrient density or the safety of food and fodder. Models predict that the effects of climate change will lead to a 55% increase in severe stunting in sub-Saharan Africa by 2050 (Lloyd et al., 2011). Dwindling livestock numbers, lowered agricultural productivity, and poor crop yields associated with climate change can leave individuals and households in a calorie and nutrient deficient state.

Although over the long-term, climate change occurs in conjunction with changes and improvements in public infrastructure to rural areas (rural water supplies, electrification) and urban technologies that can improve food security and household nutrition, new climate-related phenomena continue to emerge that undermine food security and highlight the relevance of research directed at understanding the mechanisms linking human-induced climate change to disparities in women's workloads, household health, and resource security.

## 4. Livestock holders

The FAO estimates that livestock products provide roughly one-fifth of total caloric intake and half of total protein consumed in developing countries (FAO, 2009b). Livestock holders are more likely to consume meat and other nutrient significant animal products, such as milk and eggs, than non-livestock holders because of their increased proximity and access to animal-based nutrient rich foods (Leroy and Frongillo, 2007). Livestock are also a source of income, traction, fuel and fertilizer (FAO, 2011). Many traditionally crop-based agricultural communities have shifted to livestock production to mitigate the adverse effects of climate change (Jones and Thornton, 2009). A study in southern Mali found that crop producers stress the importance of livestock production as a livelihood strategy for coping with climate change (Ebi et al., 2011). Among traditional livestock holders, adaptations to climate change include shifts in herding strategies, such as reductions in herd size and changes to herd composition, and changing settlement patterns. Research indicates that these coping mechanisms only work in certain circumstances. Pedersen and Benjaminsen (2008) found that the diversification of livelihoods associated with sedentarization of transhumant herders had a significant negative impact on food security. Typically, livestock products are exchanged at a lower calorie per kilogram (kcal/kg) value than cereals, creating a favorable exchange for livestock holders who trade for grains. When harvests are poor, this advantage backfires as kcal/kg values of grain rise significantly. Livestock holders exchange their livestock quickly to avoid animal



**Fig. 1.** Climate change related vulnerability to loss of food security among livestock holders. This conceptual framework is adapted from Füssel (2007) who provides a fully qualified characterization of the factors influencing vulnerability. Thus, the workings and mechanisms here are not new, but have been tailored to vulnerability among livestock holders.

losses to starvation and disease, therefore exchanging more kcal/kg of livestock product for significantly less of cereals. During environmental disaster, livestock holders can be more vulnerable to food security than their agricultural counterparts because of limited economic access to food and unfavorable market exchange rates (Nori et al., 2005).

Füssel (2007) proposes a generic conceptual framework of vulnerability. Building from an extensive review of the vulnerability literature (Adger and Kelly, 1999), he categorizes various conceptualizations of vulnerability, arguing that none of the four groups of vulnerability factors sufficiently capture the range of vulnerability concepts that need to be addressed in the context of climate change (Füssel, 2007; Füssel and Klein, 2004). Thus, he proposes a conceptual framework that includes nomenclature for describing any vulnerable situation in terms of the system, the hazard, the attribute of concern, and a temporal reference and a classification of vulnerability factors, which includes internal socioeconomic, internal biophysical, external socioeconomic, and external biophysical factors (Fig. 1).

Climate change is a continual force of livelihood change, as increases in unpredictable and atypical weather patterns affect communities globally. This includes escalations in frequency and severity of extreme events and more gradual increases in temperature and CO<sub>2</sub>. As we detail in later sections, these manifestations of climate change are both directly and indirectly affecting livestock holders across a range of livelihoods: pastoralists, for whom migration and herd management are key livelihood practices; agro-pastoralists, who tend to have smaller herds and rely at least in part on crop production; and urban livestock holders, who incorporate herds into a range of livelihood practices in peri-urban, urban, and slum environments. Thus, livestock holders from nomadic and settled communities with varied herd compositions and intensification strategies must all be included in the conversation about and responses surrounding the impact of climate change on food security.

#### 4.1. Pastoralism

Pastoralism is a historically resilient livelihood strategy that is often practiced in ecological systems that are too poor to support

crop agriculture. Pastoralists herd livestock in rural and peri-urban areas where access to natural resources, namely water and grazing land, is limited. Pastoralists, often characterized as mobile and with limited access to markets and social services, are highly adept at using flexible herding strategies and extensive social networks to cope with the variable nature of their environment. This adaptability, however, does not render their livelihood infallible. In many communities, climate-related events increase the flexibility required of pastoral communities. Women with limited decision making or economic power in these pastoral communities are particularly vulnerable because they occupy a marginal position in society (Glazenbrook, 2011).

According to Reid et al. (2014), there are a number of pastoralist communities that have identified innovative strategies for managing rangelands, created new opportunities for livelihood diversification, and developed unique mechanisms for bolstering adaptive capacity in challenging environments. The diversity of pastoral strategies (and variation in the effectiveness of) for responding to climate-related hazards further emphasizes the need for research and development that is sensitive to local context, including the ways that gender influences individual flexibility within an adaptive system (see also Galvin, 2009).

#### 4.2. Agropastoralists

Agropastoral populations are diverse. Some divide household members between a fixed settlement and satellite camps with migratory herds. Others come from communities that have historically cultivated crops and have not previously relied heavily upon livestock production (Jones and Thornton, 2009). A study of smallholder agriculturalists' adaptations to climate change in southern Mali was conducted as part of USAID efforts to incorporate climate change adaptations into development work. One major finding was the importance of livestock production as a livelihood strategy. Their suggestions for adaptation focus on advancing community capacity for raising livestock and improving harvests (Ebi et al., 2011).

Agropastoralists have small landholdings where many rent the land they cultivate rather than owning it. They often lack

additional resources, including labor and inputs. Livestock rearing contributes directly to food access and availability for smallholders. While smallholders may consume some of the food products made available by their livestock, they often choose to sell animal products of higher value (milk and eggs), in order to purchase lower-cost staples. Their livestock may play an indirect role in determining food security through income generation (FAO, 2009a).

#### 4.3. Urban livestock holders

Urban and peri-urban communities that keep livestock have largely been left out of the conversation about climate change vulnerabilities. The informal nature of land tenure in some contexts, such as urban slums or recently settled communities, can lead to invisibility and lack of voice. However, historically mobile livestock herders are using settlement as an adaptive strategy, and historically sedentary livestock holders are using migration to urban, peri-urban, or slum settings as an additional adaptive strategy. Urban livestock holders have limited access to inputs and services, and limited land rights. They are often comprised of newly-sedentarized pastoral groups, a population whose vulnerabilities are well documented. Discussion surrounding livestock in African slums has evolved from one of resistance, based on concerns of zoonotic disease transmission and animals feeding on waste, towards one of acceptance and an embraced reality. The transition in sentiment comes from many levels of government and greater recognition of the nutrient cycling, production efficiency with shorter travel distance for perishable products, improved household nutritional security, and market value.

## 5. Gender dynamics

Marcoux (1998) points out the importance of systematic empirical data for untangling the relationship between gender and poverty. This is particularly true when examining how gender and poverty influence adaptive responses to climate change among livestock holders. A gendered approach to understanding the impact of climate change is not new in the environment and development literature (Brody and Esplen, 2008; Chindarkar, 2012; Fordham, 2004; Marcoux, 1998; Meinzen-Dick et al., 2014; Quisumbing and Pandolfelli, 2010). However, much of the early work regarding gender and vulnerability to climate change focused on small-scale crop farming, rather than on women's roles in livestock keeping thus limiting the information available on understanding adaptation to climate change among livestock holders (Thornton et al., 2003).

Until recently, a nuanced understanding of gendered patterns of livestock management was limited by lack of sex-disaggregated data on livestock ownership. Additionally, the predominance of studies comparing male and female-headed households as a proxy for gender relationships, rather than systematically looking at variation in individual livestock ownership and management provided incomplete information (Brody and Esplen, 2008). These issues are exacerbated by the complexity of livestock value chains and the fact that "ownership" of animals does not always translate into control over marketing and decision-making about animal products. Land ownership and agricultural decision-making are commonly linked in the literature on smallholder farming (Quisumbing and Pandolfelli, 2010), but we generally lack systematic data on patterns of male and female ownership and decision-making among livestock holders. While research among certain

**Table 1**

A gendered approach to understanding how climate change is affecting dimensions of food security across a spectrum of livestock holding livelihood groups.

Livelihood	Gendered Pathways of Climate Change Impact on Food Security		
	Economic	Health	Nutrition
<b>Pastoral</b>	↑ time demand on <i>women</i> for collection of water and fuel	↑ risk of disease due to proximity of <i>women's</i> work to reservoirs of disease agents and biologic risk	↑ undernutrition due to ↓ availability of certain plant and animal species
	↑ time demand on <i>men</i> to seek out water sources with herd	↑ vulnerability to maternal mortality due to ↑ fertility associated with sedentarization	↑ undernutrition due to separation of family members from milk producing animals
	↑ productive and reproductive demands on <i>women</i> due to new coping mechanisms and livelihood modifications	↓ mental and emotional health due to increased burden and loss of social support	↑ undernutrition due to unfavorable terms of trade between animal products and grains
	↓ financial autonomy of <i>women</i> due to probable liquidation of small animal assets		
<b>Agro-pastoral</b>	↑ time demand on <i>women</i> due to migration of men for herding or wage labor	↑ vulnerability of newly sedentarized households, particularly women	↑ risk of food insecurity due to ↓ production of livestock and ↑ prices of grains and other foods, particularly in women and children
	↓ financial autonomy of <i>women</i> due to probable liquidation of small animal assets	Earlier weaning, shortened birth intervals, and risk of maternal depletion due to migration of men for herding or wage labor	↑ exposure to foods that have become spoiled
	↑ constraints on herd management due to shifts in household herd management responsibilities	↑ incidence of anemia and stunting in children	Diets may become less varied and less nutritious
		↑ susceptibility to infectious diseases that are sensitive to climate change	
<b>Urban livestock holders</b>	↑ vulnerability and poverty due to increased population growth and lack of employment opportunities	↓ access to clean water, adequate sanitation, and sufficient living areas	↑ food insecurity due to higher food prices and loss of income
	↑ susceptibility to market fluctuations based on animal foods supply from pastoral/agro-pastoral communities	↑ child mortality rates	↑ malnutrition, including overnutrition
	↓ access to inputs	↑ incidences of infectious diseases (e.g. diarrhea, respiratory diseases, and malaria)	Shift towards unhealthier dietary patterns
	Urban nutrient cycling of food waste as to animal feed	↑ incidences of chronic diseases (e.g. heart disease, diabetes) ↑ levels of stress and depression	↑ affordability, accessibility and availability of processed foods that are poor in nutrient value ↓ transportation time may improve perishability and enhance food safety

livestock holders indicates that female ownership or co-ownership correlated with greater intake of animal source foods and improved child nutrition outcomes (Jin and Lannotti, 2014), the dearth of systematic data on gendered knowledge, ownership, and management of animals has thus far limited our ability to design and implement interventions that bolster resilience.

Furthermore, the combination of limited systematic data on diversity in women's livestock ownership patterns, knowledge, and management strategies and overall lack of attention to gender in the climate change literature has often resulted in an oversimplification of women and men's experience of climate-change related events. For example, Resurrección (2013) and Arora-Jonsson (2011) identify the persistence of discourse on the link between women and environment in climate change literature and fundamental categorization of women as either "victims or virtuous" actors (Arora-Jonsson, 2011: 745) in climate-change related events. Yet, the recent florescence of literature on the nexus of climate change, gender and food security (see Kristjanson et al., 2014 and Ringler et al., 2014) for recent comprehensive reviews) suggests significant diversity in coping strategies employed by both men and women in response to climate-related hazards and threats to food security.

There are female livestock holders who are acutely vulnerable to the effects of climate change on resource availability. Dankelman (2002) identifies that extreme weather events can reduce the local availability of food, increasing women's workloads and undermining their ability to support the household. Women in pastoral communities can be vulnerable when they have limited decision-making or economic power and/or occupy a marginal social position. Wangui (2014) noted that women most vulnerable to climate change effects among Maasai are individuals with limited power and agency, bearing significant responsibility for procuring and preparing household food resources. Though, the experiences of Kenyan women in livestock-holding communities do not represent the experience of all women. Meinzen-Dick et al. (2014) and others point out that there is diversity in gendered experiences of both men and women. This is substantiated by a study in India (Ram et al., 2013) which found that women's role in decision-making surrounding the sale of livestock increases significantly during periods of stress.

Gender disparities in resource allocation and power can change over time. Climate-change related events affect the dynamics of gender roles and behavior in various ways across communities and households. In some instances men and women take on activities and roles in which they were not previously engaged (Djouidi and Brockhaus, 2011) or experience increases and/or significant redistributions in workload (such as *de facto* female headed households) as climate change events impact livelihood strategies, decisions about settlement, and patterns of labor migration (Chindarkar, 2012; Ram et al., 2013; Wangui, 2014).

The key point is that local gender dynamics shape the contours of vulnerability and the effects of climate change at the community, household, and individual level. Men and women play distinct, yet dynamic, roles in livestock holding communities, expressing control and decision-making authority over different animal resources, economic tasks, and even bodies of knowledge, all of which vary with local context. Recent research by Kristjanson et al. (2014) on gender, asset management, and climate change is a definite step towards improving our understanding of gender and vulnerability to climate change. Swaminathan and colleagues have also published an extensive set of working papers and other materials on household asset management (including livestock) as part of the Gender Asset Gap Project (see Deere et al., 2013 and Doss et al., 2013 for an overview of the multicounty comparison of wealth and household decision-making as well as a discussion of methods for assessing gender and household assets). Despite these

advances, there is a need for further systematic research that examines the mechanisms shaping individual experiences of climate change among livestock holders and provides a detailed view of the nexus between gender, climate change, and food security.

Table 1 describes some of the gendered mechanisms by which climate change is affecting certain dimensions of food security in pastoral, agro-pastoral, and urban livestock holding communities.

## 6. Vulnerability to climate change

Based on the proposed conceptual framework (Fig. 1), we identify factors in livestock holder vulnerability, sensitivity, exposure, adaptability and capacity to respond to climate stimuli, illustrating pathways for development of interventions to reduce vulnerability. To demonstrate, factors that influence vulnerability of a pastoral household to climate change may include the composition of social networks, nutritional status, terms of trade in market exchange, and annual rainfall patterns. Combined, these (alongside other factors) determine a household's vulnerability to climate change and adaptive capacity. Defined as "the ability to design and implement effective adaptation strategies, or to react to evolving hazards and stresses so as to reduce the likelihood of the occurrence and/or the magnitude of harmful outcomes resulting from climate-related hazards" (Brooks et al., 2005), adaptive capacity of pastoral households is directly affected by climate change. Pastoralist livelihoods are often able to respond dynamically to the highly variable nature of their environment. Some important adaptive strategies of pastoral populations include mobility, herd management strategies (de-stocking, splitting herds, recuperating herds after crisis through family loans), livelihood diversification (artisan work, seasonal gardens), and settlement. Pastoral households may also send a family member to work out of town or country, in hopes of receiving remittances.

However, local sociopolitical environments and their impositions on pastoral coping mechanisms can exacerbate the toll of consecutive and sometimes chronic environmental shocks associated with climate change. Many pastoralists experience heightened exposure to climate change and its consequences because they live in semi-arid and arid regions where climate change is having its greatest impact. In addition, they are highly sensitive to climatic stimuli because of the complex interdependency of livestock, ecosystem and human health that defines pastoralism. As a result, climate change has considerably increased the level of flexibility required of pastoral communities, while social structures, political policy, and economic change have simultaneously limited the historical adaptive capacity of these communities (Blackwell, 2010). This pushes many pastoral communities to the limits of their adaptive capacity.

Participation in urban livestock production is becoming a more common strategy for income generation and household food security in cities. It can be beneficial to poor and vulnerable groups by bolstering social safety nets, diversifying herd environments, increasing financial security, and increasing access to animal products and ability to utilize local resources (Richards and Godfrey, 2003). However, these livelihoods play a role in contributing to human-induced climate change, not only by greenhouse-gas emissions from livestock production (McMichael et al., 2007), but also through normal urbanization practices that include increased motor vehicles and increased purchases of waste products (e.g. plastic). The concept of urban livestock production in developing countries is being seen in a more positive light by local governments, yet the long-term impacts on climate change and food security are not well understood. Research is needed to understand the effects of this livestock holder livelihood strategy on adaptive capacity and sustainability of food security.

## 7. Applying a gendered lens

“Women have varying roles in food systems in different parts of the world. Effective planning for adaptation should anticipate the consequences on gender-specific workloads and effects on existing inequalities between men and women both within households and communities. Institutional and social changes are often essential elements of adaptation.” (Bereuter et al., 2014).

Gender mainstreaming, the intentional strategic action used by policymakers to reduce gender-based discrimination, has been a key discourse in global efforts to ensure human rights for women (Preet et al., 2010). Incorporating gender into the development of policies and legislation is an ongoing process and, consequently, must be continually initiated as new issues arise, including the impacts of climate change on food security of livestock holders. Gender-based discrimination is intensified by and intensifies pre-existing community adversity – the effects of climate change being no exception. Birks and colleagues succinctly articulate, “by incorporating a gendered lens, the pernicious nature of gender-based differentials in power is brought to light, revealing variable manifestations of gender-based discrimination” (Birks et al., 2011). Failure to acknowledge and engage the unique experiences and perspectives of women on the part of researchers and policy makers reinforces gender inequity (Glazenbrook, 2011).

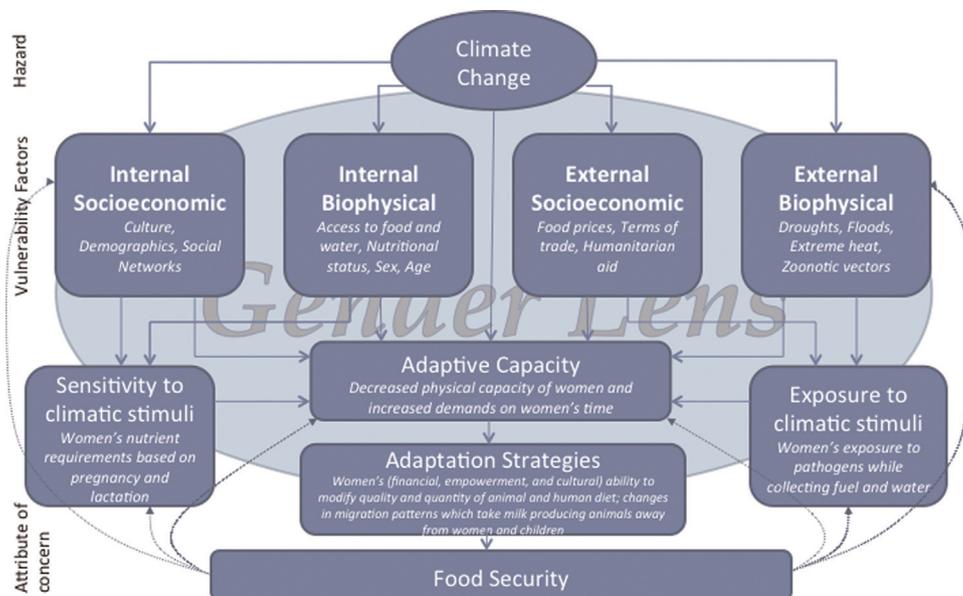
Nonetheless, a gendered approach to understanding and responding to issues associated with climate change is not being systematically applied despite significant research indicating that: (a) climate change differentially impacts poor, women and children (Alderman, 2010), (b) the local context of gender roles, attitudes and norms play an important role in shaping patterns of vulnerability to climate change (Glazenbrook, 2011), and (c) climate change will disproportionately impact nutritional status of poor and otherwise vulnerable populations (Alderman, 2010; Blackwell, 2010; Lloyd et al., 2011). Existing gender inequalities are likely to intensify with increases in climate change related phenomena (Denton, 2002). Women and men have different capacity to cope with these changes. Greater emphasis needs to be placed in research on how to support women in adapting to climate change related events because they play a crucial role in household labor, livestock keeping, food security and nutrition. Climate change mitigation must assess gender

inequalities and involve both men and women in finding solutions that address variability in adaptive response to climate change. In Fig. 2, we re-conceptualize the vulnerability framework presented in Fig. 1 by explicitly considering how gender influences climate-related risks to food security.

Fig. 2 illustrates how applying a gender lens to our adaptation of Füssel's conceptual framework can help identify specific pathways of vulnerability in livestock holding households. This diagram has been populated with examples of how adaptive capacity, adaptation strategies, and sensitivity and exposure to climatic stimuli vary between men and women and emphasizes the ways in which gender can exacerbate the threat that climate change presents to food security among livestock-holding women and their families. Use of this gendered framework can help development practitioners and researchers identify specific mechanisms and pathways of vulnerability to be targeted, limiting threats to food security and promoting positive adaptations and responses among livestock holding communities.

We detail how this gender analytic approach has been utilized in projects associated with the Feed the Future Innovation Lab for Adapting Livestock Systems to Climate Change at Colorado State University. Two specific examples from the Innovation Lab illustrate the importance of applying a gender lens to research and development in livestock holding communities and how traditional agricultural practices can be leveraged to reduce climate-related risks to food security.

“Poultry skills for improving rural livelihoods”, led by David Bunn from University of California–Davis, was conducted in rural Nepal and Tanzania. Educational programs were focused on animal disease prevention and improved husbandry practices. This approach is anticipated to reestablish healthy chicken flocks, which are intended to improve nutritional outcomes and financial stability in these impoverished communities. Examining poultry production using a gendered perspective in this context highlights the importance of women's contribution to raising chickens and selling eggs. It also provides a framework for understanding how women can benefit most from learning how to raise healthy chickens in the face of climate-change related increases in disease and drought. This project shows that in these impoverished areas, strengthening adaptation strategies that emphasize improving women's ability to care for chickens, helps improve household



**Fig. 2.** Influence of gender on climate-change related vulnerability to loss of food security among livestock holders. Examples given in italics are meant to be demonstrative, not exhaustive.

food security, especially for women and children.

“*Strengthening Tanzanian livestock health and pastoralist nutrition and livelihoods in a changing climate*, led by Jonna Mazet, targets agropastoralists in the Ruaha region of Tanzania who face challenges from climate-related changes in the prevalence of animal diseases and increased scarcity of natural resources (Mazet et al., 2009). This team developed gender appropriate educational programs and techniques to improve livestock health and livelihoods of livestock holders. Developing programs that extend to women and children is critical for sustainability of adaptation strategies and demonstrates the role that gender plays in the uptake of community interventions. Mazet’s project also brings a series of questions to the forefront about the role of gender in achieving food and nutrition security. Namely, how much time does it take for collection of water and fuel, how is this time allocated between household members, and how does it affect household nutrition and food security? What environmental exposures are unique to this environment and how does exposure differ for men and women? Could education programs on food security and nutrition targeted towards women be integrated with trainings focused on helping men with animal nutrition and disease?”

## 8. Recommendations for development initiatives

Effective assessment of international research and development projects focused on the effects of climate change on food security requires a gendered approach. Using a gendered framework to understand climate-related variability in food security among livestock holders highlights the role gender plays in shaping the mechanisms and pathways by which climate change can affect food availability, accessibility and consumption. The following is a list of implications from this research that emphasize the importance of developing context and gender-specific strategies for mediating the effects of climate change in international research and development initiatives conducted among livestock-holders.

### 8.1. Use gender analytical tools to assess climate impacts

Using a gender lens (i.e., gender analysis) among livestock holding populations experiencing climate change reveals disparities in vulnerability between men and women, as well as intersections with other categories which can exacerbate vulnerability. Gender analysis facilitates improved understanding of local contexts and development of appropriate interventions that yield maximum impact.

### 8.2. Include urban and peri-urban livestock holders in discussions of climate change impacts

The growth of the global population is forcing geographic shifts in risk and vulnerability, including urban inhabitants whose livelihoods and access to foods may suffer from extreme weather events and rising food prices. Changing centers of production also impact the livelihoods of agricultural workers as production changes in response to climate variability. This continues to be an area of important research as global population migration increases the number of urban residents.

### 8.3. Make explicit the links between livestock production, gender, climate change, and food security

Livestock holders in general have been largely under-represented in the literature that examines the gendered impact of

climate change (exceptions being Omolo (2010) and Wangui (2014)). This research highlights several risk pathways for food security among livestock holders, and how an emergence of livestock holders in urban communities should be understood for vulnerability in times of crisis.

### 8.4. Engage women in livestock-focused agricultural extension activities

Women’s needs must be identified and supported. Development activities that plan to improve food security through livestock should engage women in livestock-focused extension activities. Women’s interests, constraints, and support for developing appropriate adaptive strategies may vary from men’s given the gendered experience of climate change.

### 8.5. Identify approaches to increase legal ownership and assets of livestock for women

Female ownership of livestock has direct, significant positive impact on the food and nutritional status of families. Future research and development activities should engage new and innovative approaches to increase female ownership of and decision-making concerning livestock.

### 8.6. Develop protocols for climate researchers, including meteorological scientists, to help them understand and engage gender dynamics in their work

Research is underway to integrate gender analytics into climate research, yet physical scientists are only beginning to seek out engagement, thus missing opportunities to improve outcomes. As indicated by the World Meteorological Organization’s (WMO) November 2014 meeting that focused on gender, there are recent shifts which point to (1) a new willingness among climate scientists to analyze the role of gender in their work and (2) a recognition among them regarding the impact that gender analysis has on their own desired outcomes. The development of protocols for specific target audiences (e.g. meteorologists, climate scientists, climate adaptation researchers, etc. (see McOmber et al., 2013)) outline how and why to integrate gender analysis into these disciplines. Significantly improved outcomes are expected when gender is effectively integrated into research and practice.

## 9. Concluding remarks/implications

This article discusses the timely topic of gender relations and its influence on climate-related vulnerability of food security among livestock holders. While there is a vast amount of literature discussing connections between gender and food security, food security and climate change, and gender and climate change, this review connected these three components, as a nexus with livestock holder livelihoods. As livestock holders take on new strategies to adapt to climate change, it is important to understand how these adaptations are accepted and incorporated into the livelihoods of various stakeholders.

Additionally, we expand Füssel’s conceptual framework to highlight a gendered lens that identifies pathways to vulnerability of food security among livestock holders to climate change. Global health practitioners, nutritionists, and climatologists working to improve food security and adaptations to climate change can use this framework to define and identify factors increasing livestock holder vulnerability, such as adaptive capacity, adaptive strategies, and sensitivity and exposure to climate stimuli. Mechanisms that link climate change to vulnerability allow for improvements in

interventions to improve food security within and between households of various livelihoods.

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