

Incorporating Feminist Political Ecology (FPE) and SocioEcological Systems (SES) frameworks for fostering resilience: An example of family farmers and ranchers in the Southern Great Plains (SGP)

Lanah M. Hinsdale^{a,*}, Jacqueline M. Vadjunec^a, Nicole M. Colston^b, Todd D. Fagin^{a,c}

^a Department of Geography and Environmental Sustainability, University of Oklahoma, Norman, OK, 73019, USA

^b Honor's College, Oklahoma State University, Stillwater, OK, 74078, USA

^c Center for Spatial Analysis, University of Oklahoma, Norman, OK, 73019, USA

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ABSTRACT

Agricultural communities in the U.S. Southern Great Plains have long navigated environmental and economic change, particularly in the face of recurring drought. This study integrates Feminist Political Ecology (FPE) into SocioEcological Systems (SES) frameworks to examine how gender mediates access, participation, roles, and knowledge, impacting resilience in agricultural systems. Drawing on 57 oral histories with 76 individuals—stratified by gender—from Cimarron County, Oklahoma and Union County, New Mexico, we explore gendered experiences of drought resilience and adaptation. Of the 1273 pages of oral history transcripts, a total of 12,835 observations were coded into four main FPE themes: access (~38.91%), participation (17.28%), roles and responsibilities (23.36%), and gendered knowledge systems (20.45%). Overall, access was coded most frequently, suggesting that issues surrounding access are a particularly important entry point for fostering SES resilience. Results reveal that while women emphasize household resilience, informal labor, and community cohesion, men often frame community and resilience within agricultural labor and environmental management. Although women face barriers to land access and production leadership, they demonstrate adaptive capacity through intrahousehold production, local economic participation, and civic engagement. These findings suggest that resilience is gendered in both expression and outcome, shaped by formal and informal institutions, social expectations, and access to resources. Integrating FPE into SES resilience frameworks enables a deeper understanding of how gendered power relations influence adaptive capacity and long-term sustainability in rural agricultural systems.

1. Introduction

Human dimensions of global environmental change (HDGEC) research continues to be at the forefront of international trans-disciplinary initiatives to understand, adapt, and mitigate humans' impact on the environment in an effort to ensure sustainable futures in the face of a changing planet [1–6]. As part of HDGEC, agriculture remains a prolific proximate driver of global land-use/land-cover change (LULCC). Throughout history, humans have extensively modified land for meeting needs related to food, fuel, and fiber [7–9]. However, the scale, extent, and intensity of global agriculture has changed greatly over time, leading to questions of long-term sustainability [10,11]. Since WWI, the introduction of fertilizers, the corporatization of agriculture,

the Green Revolution, and the explosion of genetically modified crops has transformed agricultural systems and communities [12,13]. While technological innovation has allowed much of this growth, at the same time, agriculture remains susceptible to long-term impacts related to global environmental change. The intensification of present natural hazards induced by a changing and variable climate threatens the viability of agricultural operations and livelihoods, exacerbated by the overextraction and depletion of natural resources [14–16]. Consequently, agricultural change remains a core focus of the HDGEC community [17].

Agriculture can also be considered an “archetype,” one that exemplifies how the context of environmental and social systems influences the interactions between natural resource systems and social systems in

* Corresponding author. Department of Geography and Environmental Sustainability, University of Oklahoma, 100 E. Boyd St., Suite 510, Norman, OK, 73019, USA.

E-mail address: lanah.hinsdale@ou.edu (L.M. Hinsdale).

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the face and production of environmental change ([18,19], p. 85). For instance, the industrialization and globalization of agriculture intensifies operations by increasing the demand, stressing ecological resources and producer capacities to fulfill the social and economic demands, further impacting social and ecological systems through a series of feedbacks across time and space [20]. Thus, better understanding the role of agriculture as part of the local to global sustainability puzzle is a key facet of work related to international HDGEC programs such as Future Earth [21,22] and the Global Land Programme (GLP, see [23]).

Useful theoretical approaches in conceptualizing agriculture include socioecological systems (SES) frameworks that stress the importance of examining the mutual interplay of social systems and ecological systems as interdependent [24–26]. SES are comprised of subsystems of social and ecological systems that work in tandem with one another, influencing outcomes and interactions between actors and entities in each subsystem at multiple scales [17]. The concept of resilience originated from Holling ([27], p. 17; see also [28]), an ecologist, who defined resilience as a natural system's capacity to “absorb changes” and “still persist” in its altered form. This concept was later expanded to include humans and incorporated into SES frameworks [25,29]. SES resilience entails the interplay of factors within a SES that are involved in the recovery from disturbances, social and/or ecological, that restructure yet preserve the main system functions [24,30–35]. A key concept of resilience theory includes adaptive capacity, which is an individual, subsystem, or overall system ability to bounce forward [36,37]. When using a SES approach for understanding resilience, context matters. For instance, Adger et al. [24] conceptualize resilience for coastal SES by identifying key coastal ecological and social systems, such as biodiversity and spatial patterns, as well as ecosystem services, such as ecotourism or fishing habits. However, resilience can become a “muddy” concept where the conceptualizations and measurements are inconsistent between disciplines, and comparisons of definitions across disciplines are infrequent [38,39]. Thus, further defining and conceptualizing SES is important to contextualize as the actors and subsystems of SES vary based on location and multi-scalar influences.

Formal institutions, such as education and governance, are key structures in SES where interactions are unique to their context [40,41], economically [31], historically [42], environmentally [24], and socially [33,43]. However, many SES approaches often fixate on formal institutions without ample attention drawn to the informal institutions, or collective social rules, structuring SES interactions occurring at the individual, household, and community levels [26,44–46]. Further, researchers have suggested that diverse sociocultural contexts, often influenced by identity and power, are important aspects to include in SES resilience frameworks [47–51]. One such dimension of power that varies by context is the role of gender in shaping human-environment relationships [52,53].

Gender norms, acting as social contracts, operationalize formal and informal rules and regulations over human systems ([54], p. 13) that can influence the “affective responses by specific social groups” to changes in SES ([55], p. 145). Gender exists, interacts, and is materialized in human interactions through “norm-governed social practices” that can be seen as a mechanism of power affecting access to and agency in SESs ([56–61], p. 123). When considering relationships between gender and agriculture, gender identities and experiences affect decision-making processes and access to resources within SES [62]. However, research on the role of gender in agricultural SESs remains limited [63]. Resilience analyses of agricultural communities necessitate an explicit engagement with gender that identifies the role of gender and its effects on an individual's and social groups' capacity to cope with SES disruptions.

In this study, we incorporate a feminist political ecology (FPE) approach to examine the complex role of gender in SES resilience in two agricultural communities (Cimarron County, OK and Union County, NM) in the Southern Great Plains (SPG). While recognizing the

complexity of both sex and gender as natural and social constructs [57], we also acknowledge the more traditional framing of gender and sex in agricultural communities. As such, here we analyze how female and male agriculturalists are adapting to change and how their interactions within SESs vary.

2. Intellectual framework

2.1. Feminist political ecology

Feminist political ecology (FPE), a small but dynamic subfield of human-environment geography, founded by Rocheleau and colleagues [53] analyzes the convergence of gender politics and the material environment to understand the gendered power dynamics in and around access to natural resources and consequent environmental degradation [64,65]. As Rocheleau and colleagues [53] explain:

Feminist political ecology treats gender as a critical variable in shaping resource access and control, interacting with class, caste, race, culture, and ethnicity to shape processes of ecological change, the struggle of men and women to sustain ecologically viable livelihoods, and the prospects of any community for “sustainable development” (p. 4).

FPE is linked to political ecology as well as other schools of scholarship, including ecofeminism and environmental studies [53,65,66]. Political ecology assumes that there is no such thing as an “apolitical ecology,” meaning environmental problems are produced and understood from social, economic, and political lenses [67,68]. Like political ecology, FPE explores the reasons for environmental change through these lenses but positions the actors and their knowledge of resource systems as influenced by their context [69–72]. Specifically, FPE is concerned with power dynamics or “dimensions of difference” and “hierarchies of position and connectivity” in resource systems across one's intrahousehold, community, economy, environment, production systems, and institutions ([73,74], p. 459; [53,65,75,76]). ‘Intrahouseholds’ refers to the systems of distribution and production of resources, both social and environmental, *within* a household (here, with an emphasis on gender), while ‘production systems’ in this paper refer to the agricultural operations influenced by local to global economies, institutions, and available environmental resources [77]. Contextualizing environmental change includes unveiling the intersectional web of drivers, sociocultural variables, and feedbacks of human-environment interactions unique to the local environments and communities [63, 75,78,79]. More recent uses of FPE have centered on power dynamics influencing relationships with the environment, such as the varying constructions of social identity [80,81], race [82], and social systems within their context [83]. Gender remains a core area of investigation in FPE [66,71,84] where the contextualization of gender within its context is a crucial component in the FPE framework.

Gender, as one of FPE's foundational pillars, can materialize formally (i.e., politics and institutions) and informally (i.e., interactions between individuals or intrahouseholds) that are (re)produced and socially constructed in “regulated cultural fictions” to maintain hierarchies of power ([56,85], pp. 522–523; [53,69,86]). Scholars utilizing FPE often find that women continue to be disadvantaged and devalued under long-standing patriarchal structures, even when some equitable community, economic, or environmental agency is achieved ([77,87–90], p. 291; [91]). Gender can enable or inhibit people's ability to adapt and cope with disruptions in their SESs based on context specific gender norms and the environmental system.

2.2. Resilience and gender

When considering the role of gender and SES resilience, gender can affect an individual's position within an SES that can influence their

ability to adapt to SES changes. SES resilience frameworks present the interdependent complexities of SESs that affect system-wide interactions [31,33,92]. Considering gender as a construct within SES frameworks highlights the important complexities of social systems and its subsystems. Thus, incorporating FPE in SES resilience frameworks can allow for a deeper analysis of how social systems operate and interact with other social subsystems and environmental systems. Gender can influence how and in what ways individuals are able to interact with others, their social subsystems, and their environment, thus leading to gendered resilience strategies based on the available resources of their social group.

While feminist political ecology often operates at a micro-scale, providing a granular, context-specific lens on gendered power relations within a particular community or landscape, resilience theory tends toward a systems-level approach, adopting a holistic, cross-scale perspective on socio-ecological dynamics. Both efforts emphasize the need for coping mechanisms for socioecological disruptions as important components of SESs [38,52]. FPE emphasizes the social aspects of SESs and the influence of gender differences on the structure of social systems [92]. SESs are often structured to “heavily depend on gendered forms of differentiation and subordination” that are (re)produced over time to maintain power hierarchies [81] where a sole SES approach to investigating gender can dilute its complexities [93]. Gender and

dimensions of power are fundamental considerations when examining SESs and resilience [43]. Attempting to pursue a unifying approach to studying both SES and gender can overlook the complexities of each concept, where utilizing a variety of frameworks can preserve the strengths of each for holistic understandings [94]. Thus, we provide an approach to studying gender in SES resilience centered on the core pillars of FPE (i.e., access, participation, roles & responsibilities, and gendered knowledge) as avenues to explore the adaptive capacities of individuals in SES. Here, we examine resilience by assessing how individuals and SES have overcome change and their adaptive capacities as measures of their ability to do so through differing strategies and techniques. FPE contributes a nuanced view of gendered power relations within SESs, while resilience frameworks extend this insight to the systemic patterns and feedbacks that shape adaptation; together, they illuminate the interplay between local dynamics and broader socio-ecological trajectories.

3. Background and methods

3.1. Study area: Cimarron County, OK and Union County, NM

Cimarron County, OK and Union County, NM are neighboring counties in the semi-arid Southern Great Plains (SGP, see Fig. 1). With

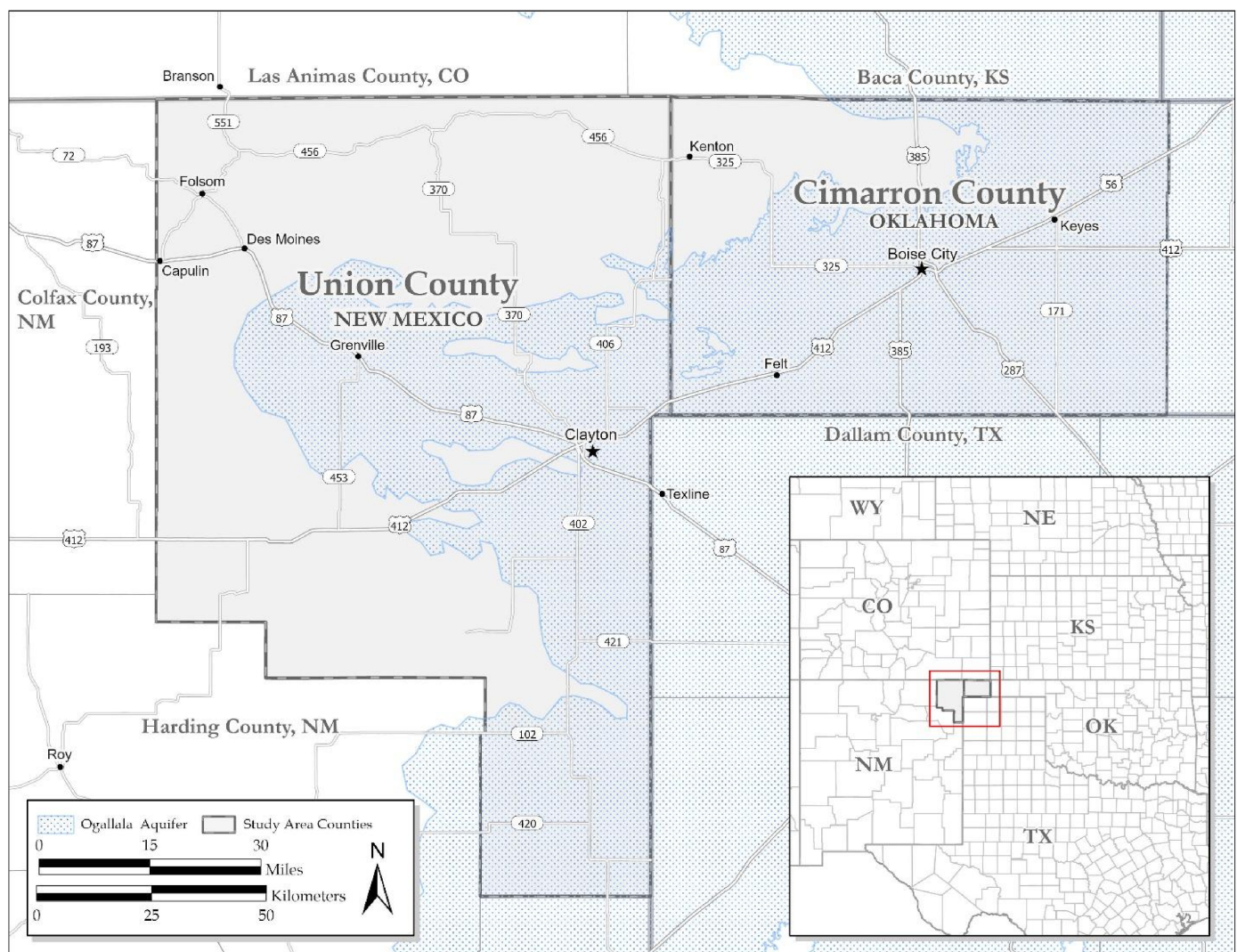


Fig. 1. The study area encompasses two adjacent counties in the Southern Great Plains, Cimarron County, OK and Union County, NM. Figure created by the authors using data layers from the U.S. Census Bureau and U.S. Geological Survey.

shared socioecological histories tied to recurrent, persistent drought, agriculture-based economies, similar demographic characteristics, and shared land and water resources crossing both state and county lines, the two counties are inextricably linked to one another and the larger SGP region [15,95,96]. Nonetheless, the two counties have experienced distinct historical livelihood and land use/land cover trajectories [97], in part due to a patchwork of local, state, and federal policies that have fostered differential land and water policies and subsequent land use trajectories [98]. This has resulted in differential vulnerability across the state line [95].

The two counties occupy a region classified as a cold semi-arid climate (Köppen BSk), characterized by 380 to 500 mm (15 to 20 inches) of precipitation annually, shortgrass prairies, and variable topography, ranging from rolling hills in the east to tablelands in the west [95]. Both counties are predominantly agriculture-based, with farming and ranching communities spread across the sparsely populated landscape. Grains are the primary crop grown in each county, though cattle is the most important agricultural commodity in terms of market

share [99]. Specialized health care facilities, specialty and agricultural equipment supply stores, and advanced or technical education, among other resources and amenities, are not easily accessible within each county. This leads many people to seek these resources beyond county and state lines, with many households traveling hundreds of miles to access goods and services [100].

The agrarian lifestyle of the two counties has deep historical roots. Euro-American settlement in the region began in the late 19th Century when U.S. government policy promoted settlement of western territories under the aegis of Manifest Destiny [96,97]. The Homestead Act of 1862, for instance, promoted western settlement of “unoccupied” lands with the offer of 160 acres (65 ha) to those willing to farm the land for at least five years [101]. Such institutional policies led to a rapid transformation of the region from shortgrass prairie to highly mechanized agricultural lands [97,100]. By the early 20th Century, both Union Co. and Cimarron Co. had seen rapid population increases and concurrent growth in both the number and size of farms (see Fig. 2). This transformation, driven by local, national, and international markets, led the



Fig. 2. Basic demographics and agricultural change. Figure created by authors based on data from the U.S. Census Bureau and U.S. Department of Agriculture National Agricultural Statistics Service.

region to be considered part of the agricultural breadbasket of the United States [102].

The agricultural boon of the early 20th century, belied by the false belief that “rain follows the plow” ([103,104], p. 186), was relatively short-lived. The pluvial phase that characterized the homestead era succumbed to a prolonged and severe drought that was further exacerbated by poor farming and ranching practices. This catastrophic, largely anthropogenic ecological disaster, infamously known as the Dust Bowl [105], lasted from approximately 1930 to 1940, and was characterized by severe dust storms and extreme soil erosion, leading to crop failure and agricultural abandonment. Along with the economic troubles of the Great Depression, increased mechanization of agriculture, and government policy that incentivized taking submarginal lands out of production, the immediate impact of the Dust Bowl was a precipitous decline in population, with major outmigration (by some estimates more than 250,000) from Oklahoma and surrounding areas to California and elsewhere [106].

While the most well-known of the recurrent persistent drought events that have plagued the region, the Dust Bowl of the 1930s is hardly alone [107,108]. The SGP experienced another historic drought in the 1950s, considered “one of the more severe of record in the Southwest and southern Great Plains” ([109], p.1). The following decade, the region experienced another severe multi-year drought, which lasted from 1962 through 1972 [110]. More recently, the SGP endured severe drought conditions throughout the 2000s, with extreme conditions in 2006 and 2007 and exceptional drought conditions from 2011 to 2013, rivaling even the driest periods of the Dust Bowl [111,112]. Abnormally dry conditions continued in the SGP throughout the 2010s and into the third decade of the century. These events underscore that drought is a recurrent and cyclical extreme climate event in the SGP. This persistent vulnerability, in part, has led to the increased reliance on intensive agricultural production techniques characterized by large-scale irrigation projects and increased mechanization of farming, further exacerbating available land and water resources [97,113].

These “slow onset hazards” ([35], p. 602) stress the SES, leading to population fluctuations, changes in government policy and informal governance regimes, and technological advancements, leaving a lasting impact on communities, production, and livelihoods [97,114]. Drought, for instance, is the second costliest disaster in the U.S. (behind tropical cyclones), with an estimated \$10 billion in agricultural losses alone per event [115]. In addition to direct economic losses, drought diminishes forage quality [116], often leading to reductions in herd inventories [117]; increases dependencies on groundwater resources [15,118] resulting in subsequent aquifer drawdown [119]; and adversely affects human physical and mental well-being [120]. Conversely, adaptations to cyclical drought events are embedded into the identities and livelihoods of SGP communities [100], often encompassing “true grit” and place attachment [96], but manifested in socioecological adaptations based on shared experiences. Understanding how drought stressors affect social groups differently within agricultural communities becomes an imperative task for the longevity of land systems.

These agricultural communities have experienced other stresses beyond drought from within their SES, as well, such as competition amongst other producers, competition for social and natural resources (e.g. groundwater), and variable institutional support for maintaining community livelihoods [118]. For instance, competition for limited resources, such as leased grazing lands in areas with mixed public and private land tenure, can inadvertently foster differential land use practices [95,121]. Differences in state and even local groundwater regulations often lead to a complex, contradictory set of rules governing multijurisdictional resources [122]. Other differences in formal and informal governance influence risk perceptions and priorities [123].

While these socioecological changes impact communities as a whole, they have differential impacts within communities and often manifest unevenly with disproportionate burdens borne along racial, ethnic, and gender divides. [48]. Agriculture, in particular, is a traditionally

gendered enterprise ([124], 139). Although both women and men are involved in agriculture, roles, access to resources, and other opportunities often vary along gender lines [125,126]. Moreover, agriculture is often perceived as a male-dominated enterprise [127]. Within the two-county study area, though, the number of women producers exceeds the national average (42% of all producers compared to the national average of 36% [99], see Fig. 2). The higher proportion of women producers in the study area has potential implications for agricultural resilience and adaptive capacity by diversifying knowledge, decision-making, and land management strategies. In what follows, we outline our methodological framework for examining and understanding the gendered dimensions of land systems to show the influence of gender in land system interactions within a drought-prone SES.

3.2. Methods

3.2.1. Selection of study area

Cimarron County, OK and Union County, NM are in the epicenter of the historic Dust Bowl. The study sites were selected as part of a larger, ongoing multi-year project on adaptation to drought as a slow onset disaster. The project unofficially began in 2008 through an invitation by the director of the Oklahoma Oral History Research Program (OOHRP) at Oklahoma State University (OSU) to the second co-author to assist in the collection of oral histories of female Dust Bowl survivors. This emphasis was inspired by a new archivist who, after surveying the already existing collection at the OOHRP, found female Dust Bowl survivor stories to be especially lacking. During the completion of the oral histories, the area was also experiencing the peak of a decade-long drought that was climatically worse than the drought that produced the Dust Bowl [111,112]. While the oral historians were predominantly interested in the past, the second co-author noticed that farmers and ranchers drew on the past as a means of envisioning agroecological resilience in the present. That experience led to multiple grants by the co-authors and the creation of a much larger resilient SES-based project to explore long-term adaptation to drought on legacy farms and ranches among Dust Bowl survivors, their offspring, and even their offspring's offspring. As such, this article uses data collected by the authors as part of larger mixed methods project which examines a large set of land-water-people dynamics over space and time, including the governance of private vs. public lands and LULCC, especially woody plant encroachment [95,121], the role of formal vs. informal groundwater governance on the growth of center pivot irrigation [15], legacy effects [128], and social capital in long-term community resilience [98], among others.

3.2.2. Oral histories of agriculturalists

As part of a larger National Science Foundation (NSF) grant on adaptation to drought as a slow onset disaster, the second and third authors completed 57 oral histories with a combined total of 76 individuals in 2015-2016. Participant ages ranged from 30 to 96 years of age, with an average age of ~73.4. As the broader scope of the project was connected to the larger household and county landscape and livelihood dynamics over time [128], we stratified our oral history collection to account for county, geographical location, age, and gender. Oral histories took 1.5 to 3 h to complete and were video and audio recorded with the option for permanent donation to the OOHRP's permanent collection (OSU IRB AS-12-60). The oral histories were then transcribed in 2016-2017 and sent back to participants for final editing and approval. Additionally, oral history participants had the option of gifting completed oral histories to one or more of the county historical museums of their choice. While the primary objective of the oral histories was to triangulate qualitative data with the quantitative household livelihood trajectories and LULCC components of the grant project, this article is positioned within contemporary scholarship highlighting the importance of women in agriculture, as well as the role women play in long-term SES resilience [129-132].

Of the 57 oral histories conducted with 76 individuals, 38 participants were women and 38 were men, resulting in ~1300 pages of interview transcripts. While many interviews were completed solo, some interviews were conducted (at the interviewee's request) with multiple generations, extended family members, and/or with spouses, which are included in the total n. In instances with more than one person involved in a particular oral history, the data used here were coded by the gender of the speaker at that point in the transcript.

3.2.3. Coding of oral histories using NVIVO

For this analysis, we use a deductive approach based on the four main themes and theoretical underpinnings of the FPE framework ([53], pp. 9–16). Oral histories were coded in NVIVO (14.1) in two phases by the first author. Inter-coder reliability was tested and calibrated between the first and second authors over the course of weekly meetings and through more in-depth comparisons at regular intervals, i.e. 5, 10, and 20 along the way, making adjustments as needed [133]. Further, we also employed iterative grounded theory approaches to allow for additional emergent codes, within the structure of the theoretically driven “forced” codes [134,135]. Cohesive excerpts of distinct snippets around a topical discussion were coded. Each excerpt was counted as one observation. Some excerpts were longer than others, yet are still considered one observation, as participant descriptions or recollections of one FPE theme constitute a distinct story or narrative.

3.2.4. FPE coding framework to examine gender in SES

Four main themes are core to an FPE framework: the participant's 1) access, 2) participation, 3) roles and responsibilities, and 4) gendered knowledge systems within SES. Drawing on the FPE and related literature, we explore each of the four themes/codes below.

3.2.4.1. Access. ‘Access’ refers to the opportunities or permissions to use ecological and/or social resources. Ecological resources can often be constrained by user-based social characteristics, like gender, race, or class. Access to ecological resources, such as land, water, and livestock, can be limited based on one's gender, where some social groups have more opportunities than their counterparts [136]. Outside of ecological resources, access can also refer to participation in community spaces or groups, institutional access in governance, or religious groups, which can be variable based on historical gender norms or restrictive roles and responsibilities [87]. Additionally, social resources can include economic resources, such as access to markets or paid labor, that can be limited by gendered expectations and value attributed to one's labor [87, 88,137]. Access to discussions or decision-making spaces can often be limited to some over others, generating gendered experiences of SES relationships [138]. Local community activism is one avenue that many women have accessed to engage and interact in their SESs more fully [139]. However, access to public spaces and decision making can be limited based on intrahousehold dynamics perpetuated by gender, adding yet another layer of complexity [77]. Understanding resource access through the lens of FPE highlights the complex web of variables influencing resource use and control.

3.2.4.2. Participation. ‘Participation’ is defined as the active and voluntary engagement with both social and environmental resources. Participation can include direct interactions with social and ecological resources through labor and livelihood procurement [82,88,136], involvement in activism or social movements [72,139], participation in community or civic organizations [87,137,140], or representation in these interactions [82,141]. One's participation, contributions, and agency can be discredited by reductionistic perspectives and context specific norms that diminish involvement and/or can deter participation [77,87,89]. Environmental participation, as discussed by Finney [82], is affected by community attitudes and “social, economic, and historical processes” and structures (xv). For instance, in the Dominican Republic,

Rocheleau (2015) found that in discussions of agricultural management and production, women and men often disagree on what issues in production are more valuable than others, where women's input is often discredited and/or dismissed because of entrenched gender-based power hierarchies within households (33). Oftentimes, women's ability to participate in certain activities may be limited due to informal rules and cultural norms at the local level, which influence what a community sees as acceptable or not. At the same time, women have human agency and mobility within their communities and environmental systems that structure how, where, and in what ways they can participate. Participation in SES can be constrained by gender norms that limit or enable engagement with community organizations, politics, and environmental resources, which are intertwined with one another. For instance, in Calakmul, women's participation in community-based organizations was both an environmental issue and a gendered one ([77], p. 6). Women's participation was “highly contested within the villages” and often limited to formal restrictions such as land ownership, one necessary component of organization membership that was typically male-dominated ([77], p. 15). While such norms might generally limit one's ability to participate, opportunities often arise to break or loosen gender norms. For instance, work by Campbell [87] illustrates how in traditional rubber tapping communities of the Amazon, women gained entrance to participating in rubber production because larger numbers of people were needed to make a statement in resisting large-scale cattle ranchers who were claiming land rights to their traditional territory. Once the resistance faded, men expected women to retreat to their respective corners, but they did not. Instead, they used their experience (and human agency) to forge new paths for continued participation for themselves and their children. Participation emerges as inherently gendered in contexts where social identity, mobility, and opportunity are deeply enmeshed.

3.2.4.3. Roles & responsibilities. ‘Roles & responsibilities’ refers to the self-chosen or imposed roles an individual takes on within their SES as a producer, leader, actor, or member, and the subsequent responsibilities required of these roles that are often dictated by social characteristics such as gender. Gender norms structuring social groups can influence an individual's ‘roles & responsibilities’ that can be executed informally, as within households, or formally in labor opportunities, institutions, or community outlets [75,77]. For instance, women are more often expected to maintain intrahousehold environments as “producers, reproducers, and ‘consumers’” whereas men and masculine individuals are often responsible for external environments, such as for-profit agriculture and related tasks (e.g. running combines, branding cattle etc.) ([53,83], p. 8; [89]). Additionally, informal roles and responsibilities can include unpaid domestic labor, subsistence production, volunteering for community activities, or maintenance of community networks [83,137,140]. In traditional agricultural communities, women are often in charge of indoor activities and household domestic chores, such as cooking, cleaning, laundry, etc., as well as home gardening, raising chickens, and other household subsistence. Further, roles and responsibilities are often determined by dominating community power dynamics via cultural community norms, and have the potential to exacerbate gender-prescribed responsibilities [88,90, 142].

3.2.4.4. Gendered knowledge. ‘Gendered knowledge systems’ are the systems of knowledge and the knowledge itself that is produced through gendered experiences with one's social and environmental system that informs an individual's engagement with their SES or ways to adapt based on these knowledges [53,136,143]. They are shaped by one's cumulative roles & responsibilities, access, participation, and experience. Therefore, it is common for individuals to have gendered experiences and knowledge exclusive to their position within the broader SES, where one's engagement with their environment or social system is

structured by gender norms. Labor processes can be seen as more feminine or masculine based on the primary social groups involved in this labor or interactions in SES, passed down through generations [88, 136]. For example, labor and production techniques can be considered uniquely feminine, where the labor and knowledge for certain tasks and techniques is typically performed and carried by women [88].

Additionally, gendered knowledge can also be applied to spaces and landscapes. Resources, natural or social, can be interacted with differently based on one's gendered experience and knowledge of these resources ([143], p. 217). However, some gendered knowledges may be undermined where another knowledge system dominates to prioritize the uniformity on a topic or the value of the topic to the broader community ([89], p. 23). Thus, the four main themes of FPE are not mutually exclusive. Rather, many of the themes converge with others and can inform each other.

3.2.5. Synthesis

These themes of FPE focus on the micro-scale systems and dynamics within SES that contribute to and reproduce gendered norms that can limit or enable an individual's ability to capacity for resilience [48]. Each theme of FPE can overlap and inform one another. For instance, access to SES resources and collectives can allow for participation in certain groups, resources, and spaces, or contrarily be hindered by one's roles and responsibilities [87]. One's knowledge of past adaptive techniques to cope with SES disruptions can be constrained by gender. Historical norms structured by gender may impose roles and responsibilities that limit engagement with these adaptive techniques while also discouraging access to crucial experiences and resources [52]. All these themes are affected by panarchies, existing on temporal and spatial scales that are structured by multi-scalar rules, regulations, and norms, where gender is the focus of this paper and a core pillar of FPE [33].

After the oral histories were coded using the above FPE framework, basic descriptive statistics were calculated in NVivo (see Table 1). Due to the n, gender stratification, and similarities between counties, we focus on gender differences, rather than differences by county. Additional emergent sub-themes within the primary FPE codes were developed from the commonalities and differences between women and men for each code. Using grounded emergent theory techniques (see above) the sub-themes were identified, discussed, and agreed upon by the first and second authors as they emerged from the primary FPE codes. From these sub-themes, we extracted excerpts to highlight that are representative narratives of the participants' lived experiences.

4. Results

Of the 1273 pages of oral history transcripts, a total of 12,835 observations were coded from the oral histories into the four main FPE themes (see Table 1). In whole, results show that codes related to access have the greatest frequency in our analysis, approximately 38.91% with 4994 observations. Roles and responsibilities is the second most coded FPE themes, making up 23.36% with 2999 observations, followed by gendered knowledge, comprising 20.45% and 2625 observations. Of all

the main FPE themes, participation was coded the least, making up ~17% of the references coded with 2217 observations. In terms of absolute difference between women and men, results show the greatest coded gender differences in frequency between dimensions of participation (3.14%) and access (3.13%).

For each main FPE dimension, we identified 2-3 emergent themes by gender (Table 2). Each main FPE theme was reviewed as a whole and then organized based on the conversation topics, allowing for divergent experiences or opinions to coexist within the same topic or emergent theme. Next, we integrate participants' own words as exemplars to illustrate and substantiate the identified themes and subthemes.

4.1. Access

Access to use ecological and/or social resources relies on the opportunities or permissions given to an individual or group. Thematic analyses of discussions about access to ecological resources reveal important subthemes in how women and men place community and manage natural resources (Table 2). In general, most participants in the study area describe their community as an expanded, close-knit family providing access to community resources, whether it was labor, assistance, knowledge, or child caretakers. Access to these resources is reciprocated through strong relationships developed at schools, churches, community events, or agricultural events, all acting as a bridge. One male participant reflected that:

"Yes, we are most definitely like a family. If someone's having a problem, and not even a problem, if somebody has a baby or gets married, the whole community throws a baby shower, throws a wedding shower. If there's a sickness in the family or an accident or somebody's in the hospital, the whole community will fill their kitchen up with food, or your house burns down." (Cimarron County, OK)

When discussing access to agricultural production and communities, all interviewees emphasized the importance and intertwined nature of these systems [98]. Yet, how women and men discuss their experiences with community and agriculture varies.

4.1.1. Placing community

Male participants tend to position community as functioning for and through agriculture, while female participants tend to define and access community through broader social relationships (Table 2). For men, an important resource is community labor for assistance with agricultural productions. The culture of labor opens access to other men in the agricultural community for unpaid assistance when needed. Community help with production (e.g. branding, mending fence, etc.) is crucial for many to survive without hiring labor for such extraneous agricultural labor needs. In terms of resilience, this is a common access point for male agriculturalists, particularly during economic downturns intensified by the area's harsh semi-arid conditions, drought, and agricultural disasters. Additionally, agriculture serves as a medium for community engagement with others. Many men express the relationships they intentionally build with others in the community as important to

Table 1

Descriptive statistics of the oral histories. Statistics were calculated in NVivo using the total observations of main FPE themes. Statistics per main theme were calculated with the total (n = 57 oral histories with 76 individuals, 1273 pages).

Oral History Coded Dimensions of Feminist Political Ecology					
	Access (%)	Participation (%)	Roles and Responsibilities (%)	Gendered Knowledge (%)	Total Coded Observations
Female	2698 (21.02)	1310 (10.21)	1516 (11.81)	1235 (9.62)	6759
Male	2296 (17.89)	907 (7.07)	1483 (11.55)	1390 (10.83)	6076
Total	4994 (38.91)	2217 (17.28)	2999 (23.36)	2625 (20.45)	12,835
Absolute Difference	402 (3.13)	403 (3.14)	33 (0.26)	155 (1.21)	

Table 2

Dimensions of Feminist Political Ecology (FPE) and emergent subthemes. Italicized text in table represents emergent subthemes from coded oral histories with key examples of differences between men and women.

	Female	Male
Dimensions of Feminist Political Ecology	Access	Placing Community
	Community through community	Community for agriculture
	Agriculture through community	Community through agriculture
	<i>Natural resources</i>	
	Agriculture through community norms and historical practices	Environmental variability and change
	Intrahousehold access (differences of natural and economic resources)	
	Participation	<i>Community Identity from Livelihood & Community Well-being</i>
	Community identity through community building (school events, fundraisers, medical support)	Community identity through shared agricultural labor (mending fences, branding, etc.)
	<i>Individual Identity from Livelihood & Well-being</i>	
	Agricultural labor and/or economic/intrahousehold support	Agricultural labor
	Roles and Responsibilities	<i>Childhood Experiences</i>
	Indoor labor, food preparation, cleaning, tending garden, & chickens	Outdoor labor, driving combines, tending cattle, & other livestock
	<i>Household Roles</i>	
	Intrahousehold adaptations & response	Household agricultural adaptations & operations response
	<i>Community Roles</i>	
	Informal leadership and/or civic related positions & community engagement in support of SES resilience	Formal leadership positions and/or (formal and informal) assistance with agricultural community support for SES resilience
	Gendered Knowledge	<i>Growing Resilience</i>
	Learning resilience strategies through familial and Dust Bowl histories	Learning resilience strategies through familial and Dust Bowl histories
	Knowledge through civic groups, women's extension etc.	Global to local production economics under cyclical drought

fostering a collective agricultural labor culture. Access to the community is part of the labor culture in the area, but some men express that the culture has changed in recent years, where community labor agricultural events are less common. As one male participant explains:

“Course, we did all the cattle work and everything ourselves. We had a pretty good crew when we’d go help—the neighbors would all help each other brand and stuff. When they got Dad to come help, we showed up. They had a full crew.” (Union County, NM).

Women are often involved in these collective community and agriculture events through supportive labor, especially through cooking and delivering lunch to field hands. While women are generally not directly

involved in agricultural labor, given deeply entrenched community and gendered norms, they view participation in these events as part of a larger community sustained by cooperating and intertwined family networks. While women may lack access to collective agricultural labor, women find other means of engaging with their community. Women express having access to schools, churches, and community groups as important for resilience. Some community activities women access to build community livelihoods include basketball games, track meets, Future Homemakers of America, rodeos, women's Extension club, and church, among others. Thus, women find community identity through community events and groups beyond agricultural production.

In sum, men tend to view community as a function of agricultural systems’ resilience, whereas women describe their roles in community care as critical to household resilience. Community resilience as a whole depends on both the collaborative agricultural labor of men and the community care labor of women.

4.1.2. Natural resources

For male participants, resilience is understood as successful agricultural management in the face of environmental variability. Women entering agricultural management roles face challenges due to gendered norms and a lack of knowledge and experience (Table 2). When discussing access to environmental resources, men often describe the stressors of drought and economic barriers as major inhibitors impacting agricultural success.

“Drought is probably one of the hardest things on a ranch because we depend on buffalo grass to feed our cattle in the summer ... The drought takes that all the way. You feed all winter, and then you feed all summer. You have to start putting a pencil to the paper, and you cannot justify feeding cattle year-round.” (Cimarron County, OK)

Across study participants, some women learned how to manage agricultural productions from growing up on a farm or ranch, while others had no experience beforehand. Most often, when women discuss personal access to agricultural production, it is often found through their spouse or community. For instance, family agricultural lands are often passed to male family members, leaving female members to depend on renting or accessing agricultural land through their spouse or ex-partners.

For women, access to land for personal productions limits opportunities to develop skills and experience when managing production. For instance, women express difficulties when stepping into agricultural spaces akin to planting “new roots” as opposed to “old roots” that you “can water” (Cimarron County, OK). Access to community agricultural labor is not as common among female agriculturalists because kin or hired labor tend to maintain agricultural productions. One female participant reflects on her experience of taking over the ranch after her husband died, especially regarding navigating the transformation into the ‘boss lady’ with hired labor:

“Well, yes. ... I was protected all of my life. My father, [I] had a really good father. He did everything for us that he should have. I’m thankful that he taught me how to do some things in the field, and ride, and things like that. It is different because you feel like, for instance, when it’s time to brand, it’s the man’s job. It was my husband’s job to go and tell each man what he would like for him to do and what part of the pasture he wanted them to gather. That was really hard for me. I did not feel like I could tell those men what to do, and different people kept explaining to me, “That’s your job now. You’ve got to tell them what you want them to do.” I have two daughters, and both of them were a really great help because they would tell me before we were going to brand, “Now, Mom, think about who you want to do certain jobs.” (Cimarron County, OK)

More commonly, women's access and management of environmental resources are located within intrahousehold production rather than

agricultural lands. Women discuss maintaining intrahousehold productions through access to gardens, game for hunting, or ranching, such as chickens or turkeys, that provided for their families. Access to environmental resources for intrahousehold productions often correlates with access to informal markets, where trading for other goods and labor was part of these productions. Some identified examples include small businesses (e.g. goat milk ice cream), repurposing of agricultural buildings (e.g. to create event spaces and/or vacation rentals), or getting together with other women to can goods and make jellies or jams. The relationships built by women's access to these spaces lead to household resilience as well as mutual reciprocity to help others in times of need. As one woman states:

“There was a lot of bartering ... You could help a neighbor, and the neighbor could pay in eggs or chickens or something.” (Union County, NM)

Women discuss access to environmental resources in different ways than men. For women, environmental stressors (e.g. extreme drought and historical events like the Dust Bowl) are more than production risk, but instead also barriers to personal health, clean intrahousehold environments, and their gardens. However, many women overcame these challenges with access to community resources, where participation in community spaces became a critical tool of resilience. Despite their traditional exclusion from agricultural production, women's access and management of intrahousehold resources are demonstrably crucial for family and community survival during economic downturns or harsh environmental conditions.

4.2. Participation

Participation refers to the active and voluntary engagement with both social and environmental resources. Thematic analyses of discussions about participation revealed sub-themes related to gender differences in community and identity groups (Table 2). As highlighted above, changing economic and social dynamics have shifted the labor culture and thus the nature of community participation. This impacts the function of gender-based identity groups and labor roles for both women and men. It should be noted that coded references between participation and access frequently co-occur. The forthcoming analysis illustrates how access can influence types of participation, and in turn one's roles and responsibilities and knowledge. It is important to remember that the FPE themes are not mutually exclusive.

4.2.1. Community identity from livelihood & community well-being

Both women and men consider it vital to maintain community culture through participating in community events. Both groups reflect on participation in past community events where church and school events are labeled as the fundamental ‘bedrock’ of their community. According to one male participant:

Yes, the churches, a lot of times the church would have a Sunday picnic during the summer. The school activities, to have a community, your school, and your churches, and your people make up these communities. We find that that's dying away today because of the fact of a lot of homeschooling. The schools have become so regulated that a lot of times that's the reason they are homeschooling. The churches, you know, it's not like it used to be. Everybody respected—if you went to a different church, that was fine. Everybody went to school. That was our community, was school. (Cimarron County, OK)

School events, in particular, are considered not individual endeavors by school officials, but rather a community effort to organize, care for, and manage. Additionally, participation in these school events is open to and attended by the entire community, even years after children are grown. Even when some individuals participate more than others, those

who don't participate as often are still considered part of and valuable to the overall community. However, in comparison, men participating in community events, such as sports or rodeos, are able to participate less as they got older because of agricultural responsibilities.

While women and men see the church and schools as an important space for engaging with their community, women identified a unique entry point: the women's Cooperative Extension group. Additionally, these homemaker groups (or clubs) are considered important for family and consumer education and critical sites for women to network and organize community work. Historically, women's Extension groups taught women how to support farm and ranch families by participating in related intrahousehold activities such as canning, quilting, and bookkeeping. Although many women's Extension programs have historically disbanded and/or been underfunded across the country, in Union County, NM, in particular, women's Extension continues to function, creating an important ‘third space’ for women. A ‘third space’ refers to the environment or conditions where cultural norms have “no primordial unity or fixity” where norms outside of this space “can be appropriated, translated, rehistoricized, and read anew” ([144], p. 37). Thus, for example, the women's Extension serves as an opportunity for many women to get involved with their communities while also contributing to agricultural operations in a different way than men. For many, participation in women's Extension is generational yet, changes in local economies and operations can hinder an individual's ability to participate; as one woman explained that in recent years, participation has decreased:

“The trouble is with our [women's] Extension. When I started, there was a lot of young women. A lot were raising a family. Now most of those women are gone, and the young girls are all too busy. They don't join because they're working, so it's just us old country women.” (Union County, NM)

In sum, community connections are valued highly by everyone in this rural agricultural community. This community identity is supported through widespread participation in prominent social institutions, like church and school. Participation in other groups (for example Cooperative Extension for women or rodeo for men) depends on and reinforces gendered norms and roles. Next, we explore how contemporary societal and economic changes have impacted participation by women and men in community groups.

4.3. Individual identity from livelihood & community well-being

Within and outside of stronghold community events such as schools or the church, we see traditional individual identity changing in the face of contemporary society. Men note how other men will participate in one another's agricultural productions when necessary. This mutual reciprocity entails voluntary help such as branding, calving, butchering, fence repair, etc. Additionally, many of the men see agriculture and community as tied together, suggesting that agriculture itself is a community project. Within these community agricultural events, men tell past stories about how families would participate in an informal market where families or individuals would trade out hay or meat with each other, thus increasing resilient households and communities. In the face of an aging and declining population, however, many participants marked a shift away from collective participation in agriculture, with more operations relying less on community support and more on individualism, paid labor, and mechanized practices, with implications for individual identity. Work by Sheehan and Vadjunec [100] illustrates the growing tensions between historic practices of community identity with more recent emphases on individual identity, especially in the face of drought.

Women, on the other hand, continue to prioritize participation through church events, rotary clubs, or helping with educational groups, such as 4-H. In some cases, with groups that have predominantly been

managed by men, such as the Soil and Water Conservation District (SWCD) Board, women's participation in leadership has steadily grown and, in some cases, now outweighs male participation. For instance, as one woman illustrates:

"Yeah, and that rotary club, it has hung on ... I always said the women liked it because (now it's only the women) they always ate. Their meetings was at noon on Wednesdays. Now, [back] then, there [were] just as many women in it as there is men. Women have taken over." (Cimarron County, OK)

However, other women report that because of distance between households and town centers, along with other time-consuming commitments, participation in such community events can often be more limited. Instead, many women participate through economic participation. Multiple women discussed having a job outside the farm as a means of making extra money or to trade out for other resources important for the household, such as groceries. One popular saying is that "for every successful rancher, there is a woman with a job in town." However, in many agriculturally based communities, options related to the economic participation of women can be limited. Often economic participation outside of agriculture entails lower paid jobs in a service industry or through historically gendered labor, such as postal services, bus driving, nursing, teaching, bank telling, restaurants, or bakeries. Thus, difficulty procuring access to resources can also limit participation for many women.

In sum, the community identity of men through shared agricultural labor (mending fence, branding, etc.) continues to stand in contrast to women's emphasis on community building (school events, fundraisers, medical support). Interviews reveal patterns of community participation have changed as labor culture and SES conditions have shifted in the area, thus impacting individual identity. The historic collective systems of male agricultural labor sharing are impacted by generational shifts in agriculture management due to an aging and ever declining population, as well as adopting technological advancements, creating an increasing view of each man for himself. Further, increased participation by individual women to positions of agricultural production, community leadership, or other outside employment may similarly detract from their access and roles in traditional community-driven resiliency efforts. This FPE analyses highlights increased access and economic participation are not always inherently more inclusive or resilient. The power dynamics of these changes and impacts on resilience both influence and are influenced by the SES.

4.4. Roles and responsibilities

Gender norms structuring social groups can influence an individual's roles & responsibilities that can be executed informally, within households, or formally in labor opportunities, institutions, or community outlets. One subtheme of roles and responsibilities for both groups is related to production, where men often are responsible for agricultural production and women often are responsible for intrahousehold production (Table 2). Many of these gendered roles and responsibilities start in early childhood and then extend to adult household and community roles. Childhood and past experiences with drought can inform the different household roles and senses of community responsibility for both women and men.

4.4.1. Childhood experiences

Maintaining and managing the household environment is primarily the responsibility of many women from youth into adulthood. Women often note the household chores for which they are responsible, one of which is the responsibility to preserve food and other necessary resources because of limited access to stores and/or cash flows. Some women also note that, during times of need, their childcare responsibilities often extend beyond their immediate family to neighbors

or other community members as they are included in the familial social network. While many of the roles and responsibilities appear to be traditionally gendered, many women still reflect fondly on their responsibilities for helping with more outside ranching chores as children, such as branding, milking, gathering eggs, or replenishing feed for livestock. Additionally, those who grew up in the ranching business often were more involved with agricultural production as young girls and mothers in comparison to farming families. Ranching often requires additional hands at a moment's notice. One woman reflects on this:

"Yeah, every ranch, the women worked, gardening, whatever came ... our neighbor, she raised turkeys, two or three hundred turkeys. That's ranching." (Union County, NM)

Men note the difficulties in balancing school and agricultural chores as children for their family's production system. However, many of the skills they currently employ as adults are learned from a young age. When delegating tasks in the household, participants often note that more agricultural chores are given to boys and young men. As one male participant recounts:

"Yes. When Dad was gone, guess who got to take care of the manly duties? I was the only boy and had three sisters ... Feeding cows, checking cows. You got to bear in mind, at my age [elementary school-junior high school aged] ..., one of my other duties was chopping wood for the woodstove." (Cimarron County, OK)

In sum, gender influences the assigned roles and responsibilities of children in agricultural households. Participation in agricultural and intrahousehold production starts early out of necessity and often involves a dual sense of self-sufficiency and responsibility to the collective. Within agricultural communities, production type (farming vs ranching) also influences the levels of access of women to agricultural labor. Still, in general, boys' roles are confined to outdoor labor, like driving combines, tending cattle and other livestock, while girls' roles tend to include indoor labor, like food preparation, cleaning, tending the garden, and chickens. This gender socialization not only begins early but also manifests into highly gendered roles as adults, both at home and in the community.

4.4.2. Household roles

In addition to the maintenance of livestock, crops, or machinery, an emerging role for men in adaptation and resilience is the need and crucial responsibility as a producer to stay up to date with technological advancements and economic changes in a rapidly changing business. Many of these skills are not learned from their predecessors; rather, many men note having to continually re-learn changing aspects of production to try to be successful in an increasingly more competitive market.

"When my dad was doing it, when it was in the fall and time to sell your cattle, you took them to the sale barn, and that's the price you got that day. Today, you can hedge cattle. You can forward contract. There's so many more tools [including virtual] available to us marketing-wise than what he had." (Cimarron County, OK)

Geographically, women note that having little or distant access to resources such as grocery stores and hospitals increases the need for self-sustained intrahousehold conditions to cope. Many women note the need to "stock up" on food and other household items as access to these resources is often hard to come by (due to distance and/or time, among other things). The anticipation of not having access to livelihood related resources is a key piece of knowledge for many women maintaining households. For instance, many women note regularly overstocking their pantries and deep freezer(s). As one woman states, to survive, they stock up on groceries:

“Why we stock up on groceries? Of course, out here, I think you live—I got a pantry. I could live in there for a month without going. You might not have your milk and bread, but you just do when you live in the country. You just stock up.” (Union County, NM)

When adapting to socioecological stressors, such as drought, women often respond by adapting household management techniques based on their previous experiences grounded in their roles and responsibilities and available resources. Many women discussed how they accessed environmental resources to maintain household environments, particularly gardening and even hunting for small animals:

“Lots of times you wouldn’t buy food that you didn’t particularly need ... Yes, we had a garden and grew a lot. Of course, I don’t garden anymore, but yes, we did have a garden and put up, you know, pickles and beans and all of the things that you can put up.” (Union County, NM)

And

“We didn’t have a lot of fresh fruits and a lot of things that we did in the drought, but to my knowledge, I didn’t know anybody who had starved to death. Be hungry but not too hungry because ... you could always go out and shoot jackrabbits or put a trap.” (Union County, NM)

Particularly during the Dust Bowl, women optimized their household environments to reduce the amount of labor needed to maintain a healthy living environment and keep dust and dirt out of the house. This included placing sheets over windows, blocking crevices on windows and doors, covering cutlery, and rearranging dishes to reduce the potential for dust and dirt to get on them. Many of these cultural cleanliness standards remain in farming and ranching communities today, even though agriculture remains ‘dirty work.’ One woman illustrates this through a story of her mother and how her labor was and remained exacerbated during and after the Dust Bowl:

“She tried—she was a compulsive cleaner. She was one of these that cleaned house before the cleaning woman came. I thought it was crazy. She was constantly cleaning, and she put the dishes away and anything to keep from having to do that. You managed because you didn’t know any better.” (Union County, NM)

In sum, the division of agricultural production roles and intrahousehold roles remains highly gendered. This seems true in response to both past and current extreme drought. Male agriculturalists feel a daunting new responsibility for adapting both new technological and global economic trends to increase the outcomes of production. Women maintain intergenerational knowledge about household and community responsibilities for health and safety in the face of the environmental and economic stressors accompanying extreme drought.

4.4.3. Community roles

For men, these environmental hazards often lead to social changes where increased attention and responsibility were pointed at supporting neighbors and community members. A strong responsibility to help others in the community, with free labor or buying from neighbors, is expressed by many men in anticipation of harsh climatic conditions. One male participant states:

“We feed everybody’s cows. We’ll go break ice. We’ll check fence. Whatever we need to do to help somebody out, we will do that ... Our drive and passion is to help people. We really try to set things up to where the drought won’t affect us if there is another drought.” (Cimarron County, OK, emphasis added)

Women also express responsibility to the community, but more so to maintain community livelihoods and collective group identity. Many women note being very involved as leaders in community events,

organizations, and institutions despite the large distances between community members and community hubs. This includes community initiatives organized by the Cooperative Extension groups, Bible schools, summer camps, as well as even helping others get medical attention, childcare, or aid. In many cases, community work extends beyond the main towns these women are part of into adjacent towns and even counties, suggesting that residents are part of a larger family or agricultural community. Thus, the responsibility to the community is just as strong in women as men, yet remains conducted through distinct roles.

Since schools are important parts of the community, maintaining them is of the utmost importance for many women. Without schools, community identity is threatened. One woman illustrates how she accessed her social capital and community standing to keep a closing school open by creating a charter school:

“Then as the charter school, unfortunately, we wanted the control of our own school, but once we got control of our own school, we lost the community support that had helped us so much. It was, in fact, we were doing—we’d work on the school, and we had to move all of the stuff to the gym so they could put in flooring and everything. Well, one day, we needed to move it all out of the gym, and I told the teachers with their husbands they had to come and help.” (Union County, NM)

In sum, a sense of community responsibility for SES resilience is strongly held by both women and men. Men’s roles include assistance and support for agricultural production, while women’s roles include civic related positions and community engagement. As expected, these roles and responsibilities often overlap with other themes in the coded FPE framework. Next, we explore how roles and responsibilities can shape gendered knowledge of how to execute these skills, which can limit or enable access to resources or participation in spaces or events.

4.5. Gendered knowledge

Gendered knowledge systems are the systems of knowledge and the knowledge itself that is produced through gendered experiences with one’s social and environmental system that informs an individual’s engagement with their SES or ways to adapt based on these knowledges. Gendered knowledge often originates from these spaces for the production or sharing of knowledge related to skills, new techniques, or information shared between community members. For many study participants, resilience strategies are learned through familial and Dust Bowl histories. The knowledge of cyclical drought sustains an intergenerational discussion between women and men in their respective gendered roles in intrahousehold and agricultural production.

4.5.1. Growing resilience

Both women and men are attentive to harsh climatic conditions, particularly past and present drought, noting that overcoming these challenges often requires an attitude to persist and persevere. Many women growing up in the area note the knowledge their parents and grandparents passed to them. For instance, those who survived the Dust Bowl and suffered through the limited access to environmental resources, such as household (potable) water, found ways to manage by being aware of how and why water was used for household needs. Often such knowledge is passed down intergenerationally. For example, many women note never throwing away left over water down the drain, but rather, using it to feed plants or water the grass. Further, many women are emphatic about the importance of Cooperative Extension clubs for learning canning, sewing, gardening, and crafting, which are important for fostering resilient livelihoods in the harsh, semi-arid region. As seen above, the community itself is a core resource that many participants capitalize on to share knowledge related to agricultural survival and socioecological resilience.

Men often discussed learning skills or attitudes to cope with harsh

environmental conditions for agricultural productions that came from their parents from Dust Bowl conditions or learned from past experiences where “everything is focused on how to handle the drought.” Knowledge of environmental conditions and agricultural production is generally passed down through generations, but also learned from experience as cyclical drought conditions change from year to year. One male participant reflects on his ranch built with his business partner:

“You’d have to feed extra for the calves. You’d lose some calves. You’d pull the cows down before you had grass in May and June. [My partner] would calve now, late, and oh, I had a hard time with that because the calves would be so late in the fall. But it’s in sync with nature, and it reduces the feed that you have to feed that cow before she calves. She’s ready to start producing milk. Well, you have grass this time of year and when the calf is just starting to grow. When you think about it, the deer, when they fawn, horses, naturally they don’t foal until late in the season. It’s just nature, and [my partner] was very adaptive to changing our ranch to that kind of a procedure. It was quite interesting. We talked about it a lot. It’s more of a holistic type of ranching.” (Cimarron County, OK)

Additionally, many men reflected on characteristics such as “grit” and “endurance” of their forefathers as contributing to their ability to make it through the Dust Bowl. Such a mentality is considered a key skill to make it in the agricultural business for the productions themselves, as well as navigating variable economic markets.

“I’d say work hard for it and don’t overextend yourself because this is a big business and it’s a big game. It takes big players, but make sure that you can play in the game that you’re wanting to play. If it’s not that game, then back off just a little bit. Always keep money right and keep that ahead, and you’ll be doing good.” (Union County, NM)

Indeed, SES resilience requires an understanding of global to local production economics is an important part of operator knowledge, especially in the “breadbasket” production communities linked to multi-scale markets [102], as well as attention to cyclical drought. Everyone recognizes the variability of agricultural production based on climatic conditions, such as precipitation variability. As agriculturalists, men find their productions controlled by nature as much as by themselves. Thus, men build knowledge of maintaining agricultural productions in the semi-arid area through experience and careful monitoring of the climatic and economic conditions. This knowledge and experience become crucial as the agricultural business is rapidly changing. As one male participant notes:

“Oh, you always have to. You always have to. Everything costs more money. It just costs more money to operate. You always, almost always have to look at expanding. The other thing that goes back to the drought, the point of view that we talked about, that if you’re in that expansion, you always have room and you can come back. If you’re in that mode where you’re looking to get bigger when the drought comes, then you can kind of scale back. If you’re here at capacity when the drought comes, then you’ve got to slow down and then go back. Those kind of hardships don’t hit you as hard if you’re kind of always looking to expand and if you’re looking for opportunity like that.” (Union County, NM)

In sum, gendered knowledge about stressors to environmental resources can often be passed down through generations or produced in spaces of participation surrounding an individual’s roles and responsibilities. Understanding SES through the lens of the four main themes of FPE highlights overall agroecological resilience as an iterative and historical adaptive process.

5. Discussion

This case study contributes to ongoing calls for inclusion of the

sociocultural contexts of SES resilience (beyond governance) with a focus on the social differences of actors within SES [49,145]. The role of gender in SES resilience is multi-faceted and is affected by multi-scalar influences. Viewing gender in SES through access, participation, roles and responsibilities, and gendered knowledge highlights the variations in how actors within SES navigate the systems before, during, and after SES disruptions. In particular, the results highlight the individual experiences of SES disruptions and how these disruptions affect multiple generations and groups across time and space. This work also illustrates how women and men adopt adaptive strategies that vary based on gendered access, participation, roles & responsibilities, and gendered knowledge within SES, creating a gendered experience of SES resilience. Both sets of experiences and strategies can contribute to SES resilience, but interact and affect the overall functioning of SES differently. For example, adaptive strategies composed by women in community spaces may benefit the resilience of social systems more, while the adaptive strategies adopted by men may benefit agricultural operations, yet both feed into the overarching SES, such as the local economy, livelihoods, and use of natural resources. Thus, these four main themes of FPE are important for investigating SES resilience and gender by identifying resources, patterns, and effects of SES disruptions for agricultural communities in the two counties.

5.1. Research implications

This case study shows the complexities of social systems in agricultural communities that extend beyond formal institutions, thus broadening the scope and explanatory power of SES resilience studies [26,33,44]. The study explored how gendered norms and identities perpetuate gendered responses to SES disruptions and unique adaptation strategies that reflect the participants’ positioning within the SES. Out of the four FPE themes, access was coded the most frequently, comprising ~40% of the total observations (with over 15% more observations than the other coded FPE themes), suggesting that issues surrounding access are particularly important and may serve as an entry point for fostering SES resilience. Discussions of roles and responsibilities accounted for almost a quarter of total observations (23.36%), closely followed by gendered knowledge systems comprising a fifth of the total observations (20.45%). Thus, both roles and responsibilities and gendered knowledge systems may inform one another, where some labor and engagement with SES is uniquely gendered. Participation was coded the least, accounting for 17.28% of total references, suggesting that participants emphasized other FPE themes more than participation. At the same time, as seen throughout the results, these themes can co-occur and influence one another. For instance, women’s limited access to agricultural productions because of gendered norms dictated roles & responsibilities and participation in certain spaces, leading to highly gendered knowledge systems about how to cope with harsh social and environmental conditions. Knowledge of resilient strategies is specific to the household or intrahousehold productions for women, whereas men, in their discussions of adaptation strategies, leaned towards skills and management techniques to maintain agricultural productions or financial stability.

In generalized categories, women and men may access the same community resources but for varying reasons and differing means. Additionally, the FPE themes with the most observed differences between women and men existed in access and participation with ~3% difference (each); the results suggest differences in how and in what ways women and men contribute to fostering SES resilience. As seen in the results, women often accessed their communities to support social networks and share resources for coping with climatic conditions or other perturbations, whereas men often accessed their communities for agricultural labor in support of their agricultural livelihoods. Thus, these informal institutions play a role in how individuals interact with other factors of SES, making resilience gendered. Incorporating gender into SES studies can reveal more nuanced understandings of SES resilience.

Community is a critical resource and subsystem for agricultural communities in both Cimarron and Union counties, where agriculture and livelihoods are deeply intertwined. Additionally, the community served as an important factor for individuals to remain resilient in SES disruptions. For men, resilient agricultural strategies were achieved through utilizing their local social networks to share knowledge on how to cope with harsh environmental conditions, as well as accessing and providing labor to maintain intensive agricultural productions. For women, community is an important ‘third space’ to maintain key social relationships between other community members, such as the Extension groups or religious groups, that bond community members and share resources with others in times of need. Community and social networks are critical subsystems of SES that provide opportunities to foster resilient strategies [98,144,146,147].

Gendered adaptation strategies in Cimarron and Union counties often involve difficult trade-offs between livelihood maintenance, social reproduction, and environmental stewardship. For men, maintaining agricultural production often requires investing in new technologies or scaling operations (with an inward focus on the self or household), sometimes at the expense of community-based labor sharing or soil health. Women, by contrast, described trade-offs between participating in the external formal labor force and maintaining household-level resilience activities such as gardening, food storage, and community leadership. In some cases, these decisions were constrained by structural factors such as land inheritance norms or limited rural employment opportunities. These trade-offs illustrate how adaptive capacity is shaped not only by ecological constraints but by gendered expectations, cultural norms, and unequal access to institutional and material resources. While structural forces no doubt impact the possibilities of SES responses, on the other hand, survivors of the Dust Bowl and their offspring are a testament to the power of human agency.

A critical implication of this study is recognition that broad national or international strategies to promote resilience on a local level may or may not be effective [148]. In the case of the two counties in our study area, support for maintaining existing community resources and groups would be more helpful than top-down solutions and increase the longevity of these solutions. Further, how and in what ways different gender groups access and participate with their community for resilient strategies varies and can greatly influence who is more vulnerable in following SES disruptions. Thus, finding solutions that are mindful of local adaptation strategies to SES disruptions and effectively operate in a larger scale policy and decision making are more likely to be effective in the long term [17,149,150].

Traditional gender norms influence SES mobility for the participants. Examples of women managing agricultural productions are sparse. In such cases, women expressed the difficulties of being a new farmer, perpetuated by familial and societal gender norms for roles and responsibilities in an agricultural lifestyle. Specifically, access to agricultural lands and labor to support large-scale agricultural productions is a challenge to these women, often evoking strategies of land transfer from their spouse or hired labor instead of internally sourced from the community. In contrast, men identified the scale of agricultural productions to be a key obstacle to overcome when social and environmental resources may or may not provide ways to cope. The generational and experiential knowledge expressed by men when adjusting to drought conditions, fluctuating markets, or variable governmental support is not seen as strongly in women. Additionally, access to community resources varies between genders, where men identified strong social networks as key to maintaining agricultural productions. Thus, to foster resilience, resources and support is based on gendered access, participation, and knowledge of resilient strategies [52,55].

From this study's results, women express greater historic difficulty navigating SES disruptions, often having less access to traditional agricultural knowledge and related resources, while being essential to SES resilience through more informal means. At the same time, agricultural operations are increasingly run by women. By recognizing women not

only as vulnerable populations but also as active agents of resilience and innovation, future policies can cultivate more inclusive, sustainable, and effective responses to the intersecting challenges of climate change, resource degradation, and rural transformation. Future steps to investigate these difficulties and develop solutions to overcome them would focus on women in relation to SES subsystems and components. Understanding context-specific gender disparities is critical to understanding SES adaptation and resilience. Community-engaged approaches to SES resilience provide an opportunity to provide valuable insights for local, regional, national, and international policy and decision makers when supporting agricultural communities during times of SES disruptions. Case studies such as this one can provide insights on better ways to approach investigating SES and guide more holistic resilience approaches.

5.2. Theoretical implications

In general, applications of the FPE framework were successful in identifying participants' adaptive capacities, resilience, and long-term sustainability. Integrating FPE frameworks advances SES scholarship in two main ways. First, rather than treating gender as a background variable or a single “social factor,” this approach operationalizes gender as power-laden relations that structure multiple SES processes at once—access, participation, roles and responsibilities, and gendered knowledge—and thus shape adaptive capacity through feedbacks across household, community, and production systems. This framing also makes visible how informal institutions (e.g., labor-sharing norms, community care networks, and gendered expectations) function as core components of resilience, extending SES analyses that often privilege formal institutions and production-centered indicators.

Second, applying FPE within an SES lens shows resilience as not only system persistence or technical adaptation, but as the product of gendered tradeoffs and differentiated contributions that sustain system functioning through distinct pathways. Emergent subthemes complemented and refined both frameworks by showing access as simultaneously ecological, social, and institutional, and by demonstrating that participation operates not only within discrete SES components but also as a mechanism for producing social identity and belonging under changing rural conditions. Taken together, these findings suggest that “gendered knowledge” is not an additive category but an outcome of constrained and enabled participation pathways: limited access to certain production spaces shapes what is learned, valued, and transmitted across generations, producing distinct yet interdependent knowledge systems that together sustain long-term resilience.

5.3. Policy implications

The insights from this study have important implications for the design of SES resilience policies that explicitly address the gendered dimensions of resource access, labor, and institutional participation. In particular, the observed differences of coded observations in the FPE themes of access and roles & responsibilities suggest possible entry points for policymakers and government officials for fostering SES resilience. Resilience interventions—particularly those targeting drought-prone agricultural systems—must move beyond technocratic or production-focused models to engage with the full spectrum of labor and adaptive strategies that sustain communities.

First, our findings underscore the importance of recognizing and valuing informal labor systems, particularly those managed by women. Cultivating resilience is often assumed to resolve underlying SES dynamics inhibiting sustainability initiatives [93]. However, omitting a critical gender lens from resilience policy shortchanges the complexities of how gender roles and identities manifest and organize agricultural communities [94]. Commonly women-led activities such as food preservation, subsistence gardening, child and elder care, and participation in civic, educational, and mutual aid networks are often excluded from

formal resilience planning, despite their centrality to household- and community-level adaptation. Integrating these practices into disaster preparedness and agricultural extension programming—through funding, training, or inclusion in formal metrics of resilience—would better reflect the lived realities of diverse producers and caretakers in semi-arid rural regions. Second, the erosion of women-led civic infrastructure, such as the women's Extension groups and local women's organizations, weakens the community's adaptive fabric. These groups historically played critical roles in sharing knowledge, coordinating aid, and building social capital in the face of environmental change. Policy-makers and funders could support the revitalization and modernization of these civic institutions through targeted investment in rural women's leadership, cross-generational knowledge-sharing initiatives, and community-building efforts that reinforce localized adaptive capacity. Third, land use and drought resilience policies should explicitly address gendered access to land, water, and decision-making authority. Programs designed to promote sustainable water use (e.g., aquifer recharge, drought conservation incentives) should include provisions for women's participation in planning, ensure equitable access to land leasing or ownership opportunities, and recognize the barriers women face in accessing agricultural financing, labor, and machinery. This could include policy reforms that incentivize joint land ownership, expand access to credit for female producers, or require gender-equity audits in agricultural relief distribution. Lastly, here, we focus on drought as a slow-onset disaster, yet insights from comparisons between women and men can be applied to investigations of other natural hazards to inform resilience interventions and planning [151].

5.4. Scope and limitations

This study is based on a qualitative analysis of oral histories conducted in two counties within the Southern Great Plains. The findings from this study likely apply to other agricultural communities where gendered cultural and historical norms continue to play a role, such as Great Plains communities influenced by the extreme weather and long-term, cyclical drought [152,153]. Insights drawn from this study may also apply to other semi-arid regions where bolstering uniquely women-led spaces, such as extension groups, agricultural organizations, and recognition of gendered knowledges and experiences, may increase resilience (see [154]).

While the sample is relatively large for a qualitative study ($n = 57$ interviews, 76 participants), we note that it is not statistically representative of all agricultural communities in the region or beyond. Further, the data were collected 10 years ago and should be interpreted from pre-Dust Bowl to the mid-2010s (a time of severe drought at the same level that produced the Dust Bowl). This database remains extremely valuable as many Dust Bowl survivors are now deceased. Given the nature of oral histories, the data represent a long view through one's own lived experiences and perceptions and should be interpreted as such. The data reflect gender binaries common in traditional agricultural contexts and do not include nonbinary or transgender perspectives. Further, while the study focused on gender differences, intersections with race, ethnicity, and class were not deeply analyzed. These limitations suggest opportunities for future work to explore more diverse identities and comparative cases across geographies.

6. Conclusion

This study contributes to nexus thinking by examining how gendered social roles mediate adaptive responses to interconnected water, food, and land systems under climate stress. In drought-prone agricultural systems like those of the Southern Great Plains, trade-offs between water availability, food production, and land use are mediated by gendered labor divisions and institutional norms, making them prime candidates for nexus analysis. Understanding the influences of social differences on the structure and functioning of SES within their context is crucial to

investigating SES resilience before, during, and after SES disruptions. We focus on one of the many crucial social differences affecting SES resilience and contribute to the ongoing calls to emphasize and expand how and in what ways we study the social piece of SES resilience frameworks. Treating gender as a critical variable in SES resilience studies, as seen in this study, shows how gender influences an individual's and community's capacity to cope with SES changes. Investigating the barriers to SES resilience is of local, national, and international importance, as the study area is part of the breadbasket of the United States [102] and the world [155]. This study illustrates the potential understandings of resilience that could be garnered by incorporating aspects beyond Ostrom's focus on governance as the primary "social" part of the SES. Our work shows one potential approach, combining SES resilience and FPE literature, to incorporate other important social characteristics that play a role in SES structure and functioning to highlight areas for attention to support agriculturalists in SES disruptions. However, we acknowledge that there are many potential approaches worth pursuing in light of increasing human-environmental changes.

By bridging feminist political ecology with socioecological systems, this study offers a critical lens for developing integrated, gender-responsive strategies for fostering resilience related to water, food, and land security under climate stress. FPE enriches nexus frameworks by making power, norms, identity, and informal systems visible. The findings presented in this study show how gender infiltrates subsystems and the interactions within them, further impacting the SES. In the agricultural communities in the two counties presented here, gendered differences are revealed through how and in what ways different gender groups can be resilient in the face of SES disruptions. We argue that women and men often work in distinctly different but complementary and supportive ways. While women in agriculture continue to remain seemingly invisible, understanding the nuances of these gendered differences is key to supporting agricultural communities and production to promote sustainable, long-term solutions.

CRediT authorship contribution statement

Lanah M. Hinsdale: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Jacqueline M. Vadjunec:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Nicole M. Colston:** Writing – review & editing, Writing – original draft, Funding acquisition, Data curation. **Todd D. Fagin:** Writing – review & editing, Writing – original draft, Visualization, Funding acquisition.

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Declaration of competing interest

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