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Wyoming's Aging Agricultural Landscape: Demographic Trends Among Farm and Ranch Operators, 1920–2007

By Henry B. Glick, Charles Bettigole, Devin Routh, Lindsi Seegmiller, Catherine Kuhn, Ambika Khadka, and Chadwick D. Oliver

On the Ground

- Across the United States, farmers and ranchers are getting older, and fewer young operators are entering the agricultural workforce than in the past.
- We statistically and cartographically explored demographic trends among farm and ranch operators in Wyoming to see if and how the agricultural community was aging.
- Census records indicate that Wyoming's agricultural community is in fact aging, and that the relative proportions of younger operators are dwindling rapidly.
- With a changing local agricultural community, we face risks associated with loss of local knowledge, loss of tradition, and loss of investment that stem from a deep-rooted sense of place.
- We face a fundamental challenge in inspiring young agriculturalists to take up residence in the state to help replace those of retirement age.
- This might be accomplished through shifts in education, public policy, economic incentives, or through targeted cultivation of personal connections to the land.

Keywords: US Census of Agriculture, farm operators, High Plains, agricultural demographics, aging farmers, land management.

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The agriculture of the United States, including both farming and ranching, has experienced dramatic social and economic shifts over the last century. The family farms that once dotted the landscape and employed nearly half the US work force have been replaced by large, often mechanized, operations supported by a mere 2% of the country's work force.[1,2] Concomitantly, the number of farms has dropped 63% since 1900 and farm size has increased by 67%. Despite this increase in size, however, current farmers and ranchers continue to struggle to maintain economically viable enterprises. Since 1930 the proportion of farms that had off-farm income has more than tripled[2]—a reflection of more lucrative opportunities elsewhere.

An Aging Agri-Social Landscape

The physical and economic challenges of farming are reflected in the farm operators themselves, who make up an aging community nationwide. Over time, fewer and fewer young operators have taken up land-based occupations, and the USDA[3] reports that over half of all operators are over the age of 55. These are changes not in the practical, mechanical, or earth-bound facets of agriculture, but in the social fabric of agriculture. This is the fabric that holds together the individual operators, their families, and their support networks. Here we have adopted the term "agri-social" to create a distinction between the human and nonhuman dimensions of agriculture, and to speak specifically to this social fabric.

An aging agri-social landscape has been documented at various scales and in various geographic locations for decades.[4–7] Our interests were in whether these trends held true for the High Plains of the American West, where large tracts of working land continue to dominate much of the landscape. This research was broadly focused on cultivating landscape-scale stewardship practices that support ecological resiliency without sacrificing the values of regional stakeholders. We

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therefore set out to identify geographically widespread, long-term trends among those most directly impacted by our work: farmers and ranchers of Wyoming (Fig. 1). We felt that a clearer understanding of the demographic trends among farm and ranch operators was essential to socially responsible research—research whose goals and recommendations are not at odds with the communities most closely tied to the resources of interest. This work will provide valuable perspective to the agricultural community, community outreach specialists, and legislative executives responsible for bringing policy into practice.

What We Did

We evaluated demographic trends across Wyoming through time. We hoped that this would provide a more comprehensive understanding of current agri-social conditions than we collectively possessed. We also hope that this would shed light on traits of the farming and ranching community that were not necessarily intuitive or accessible, but which should be taken into consideration when planning for meaningful research and partnerships in the region. To do this, we relied on statistics from the US Census of Agriculture, which has been conducted approximately every five years since 1840 by the US Department of Agriculture's National Agriculture Statistics Service (NASS). Agricultural census records for Wyoming have been kept since before Wyoming was even a state, although more detailed information was recorded beginning in 1890, the year Wyoming joined the Union. In early censuses, the structure of the records was not standardized, and over time there has been a trend towards capturing greater and greater amounts of information from census participants. We conducted our analysis on the portion of the data that could be unified: 1940–2007 for county-level data, and 1920–2007 for state-level data.

Technical Details

We chose to represent our findings using cartographic and statistical analysis. We created maps by manually digitizing census records and then joining them to spatial datasets. We then performed cartographic analysis within a geographic information system (GIS) using ArcMap 10.1 and ArcScene 10.1 (ESRI, Redlands, CA). To develop statistical models we manipulated tabular data using RStudio v. 0.97.551 (RStudio, Inc., Boston, MA). We chose to employ least-squares linear regression[8] as a way to identify how well the proportions of farm and ranch operators could be predicted by time for each of four age classes: ages 34 and younger, ages 35 to 54, ages 55 to 64, and ages 65 and greater. Separate regression models were fitted for each class. For county-level statistics we used nonparallel multiple linear regression[8] (Unpublished manuscript, T. G. Gregoire) to develop models that made use of all available observations, while simultaneously producing county-level estimates, effectively increasing sample size and reducing residual standard error. Here, the primary predictor, time (census year), was supported by 22 indicator variables corresponding to county names, and 22 interaction variables (time × indicator). For state-level statistics we used simple linear regression to model each age class independently, although the number of age classes was expanded to include 1) ages 24 and younger, 2) each nine-year bracket from ages 35 through 64, and 3) ages 65 and older. We chose to examine changes in the relative proportions of farm and ranch operators, as opposed to the number of operators, because as agricultural technology has improved and other sources of income have influenced local residents, the number of operators has varied in ways that do not necessarily reflect Wyoming's agri-social health. We also felt that exploring relative proportions would limit confounding economic influences (e.g., changing subsidies, fluctuation in property values, etc.) that might further influence trend analysis.

In addition to modeling the proportions of each age class through time, we also examined the average age of operators through time at both county and state levels, again using nonparallel multiple linear and simple linear models, respectively.

From each model we derived estimates of slope coefficients, estimates of model strength (coefficients of determination; R^2), and determined whether there have been statistically significant changes in the proportions and ages of operators across time. We coerced the results of all regression models into cartographic form to represent large quantities of tabular data in concise visuals (see Fig. 2 for key). Although informative, the results must be interpreted within their context. Farm operator statistics are voluntarily offered by census participants and might have inherent bias in rural areas, in areas where residents are particularly sensitive to public privacy, or in areas where residents are sensitive to cooperation with government employees. Further, the statistics we used represent only principal farm operators. Tertiary operators have not been accounted for in trend analysis. Statistical significance specified in the written text was evaluated with respect to a threshold where $\alpha = 0.05$. In cases of nonparallel multiple linear regression, coefficients of determination correspond to simple linear regression models.

Results

When we examined the proportions of farm and ranch operators within each county we found a predictable pattern of change: the proportion of younger operators has declined with a concomitant increase in the proportion of older operators. This pattern is such that when considering operators across the full range of ages, those at the extremes of working age have experienced the most dramatic shifts. Since the 1940s, all but two of Wyoming's counties (Sweetwater and Natrona) have experienced statistically significant declines among the proportions of operators ages 34 and younger (Fig. 3A). These declines are not as consistent for operators ages 35–54 (Fig. 3B), although the majority of counties show significant declines for this age group as well. The proportion of late-middle-aged operators ages 55–64 (Figs.

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Figure 1. Project study area: counties of Wyoming, USA.

3C and 3D) has fluctuated over the last seven decades, revealing no clear trends, whereas the proportion of the oldest age class (65 and greater) mirrors the youngest with a statistically significant increase for virtually all counties (Fig. 4A). When we look across the state of Wyoming, pooling data from each county, we again find that the extremes in age have changed more than those in the middle (Figs. 5A and 5B). With the exception the 45–54 age class, the state has experienced statistically significant changes within all age classes since 1920.

When we analyzed changes in the average age of farm and ranch operators (Fig. 4B), the results fell hand in hand with the changes in the proportions of age classes. At the county level, every single county in the state has experienced a significant increase in the average age of farm and ranch operators since 1920. Lincoln County has had the greatest rate of change, where the average operator age has increased by roughly 66 days per year since the 1940s. For the state as a whole (Fig. 6), Wyoming's agricultural community has aged roughly 44 days per year since 1920.

The relationship between time and proportion for each political unit (county or state) and for each age class is not fixed, and for some counties or age classes the pattern of change is stronger or more reliable than for others. For example, when looking at the proportion of operators ages 34 and younger (Fig. 3A), Teton County exhibits the greatest rate of change with a decline of –0.27% per year. In other words, if young operators made up 30% of all operators in one year, they would represent only 29.73% of all operators the following year, all other things being equal. However, for the 34 and younger age class, the relationship between time and proportion is most reliable for Goshen County, where time can explain 88% of the variability, or changes in, this age class' relative proportion over time. We encourage the reader to consider the images closely.

Discussion

It's clear from the data we present here that whether looking at county or state levels, Wyoming's farm and ranch operators are getting older and young agriculturalists are a declining minority. It comes as no surprise that the positive trends for senior operators are the reciprocal of the negative trends among younger generations; without a young, motivated workforce to take up occupations on the land, older generations continue to fill those roles. Middle-aged operators show less dramatic changes through time, although the relative proportions of these operators are highly variable, with both high and low points.

The changes we present in Figures 3A–5A are all quite small—fractions of a percent or a couple months change in age per year. Although many of these changes are statistically significant, what do they mean for the practical scope of agriculture in the state? From a numbers point of view, if we consider each of the modeled trends independently, ignoring the effects of other age classes or geographic areas, a somewhat dire future is forecasted. By 2033 there will be no operators younger than 35; by 2050 30% of all farm and ranch operators will be between 55 and 64 years old and over 34% will be of retire-

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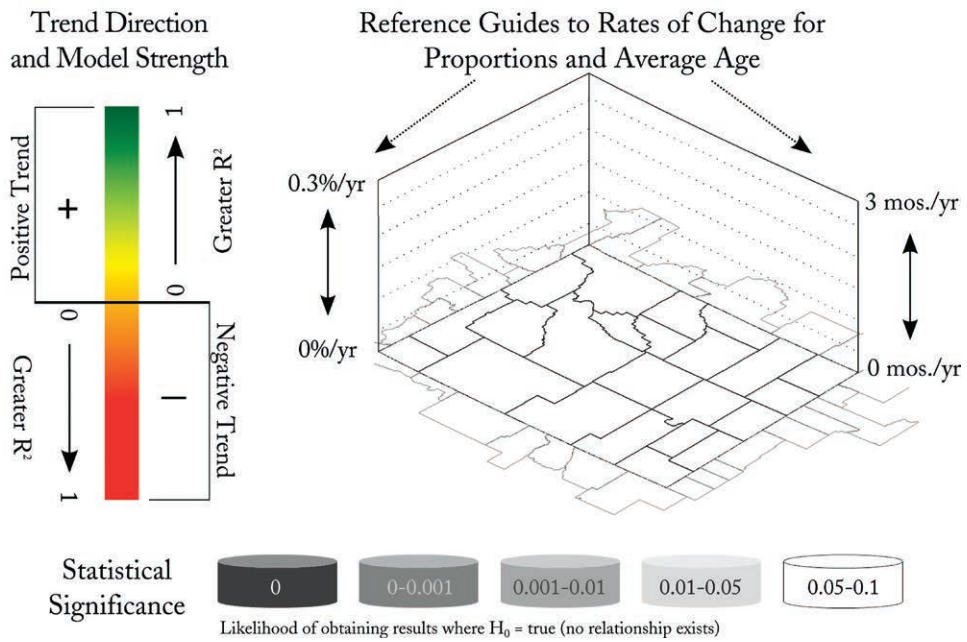


Figure 2. Key to cartographically represented regression models shown in Figures 3–5A. Trend direction (*positive* or *negative* regression slope) is specified by either green or red hues, projected above or below the neutral plane respectively. Model strength (coefficient of determination, R^2) is represented by the relative shade of a given hue. The rate of change (regression slope) is represented on the vertical axis, where greater height away from the neutral plane equates to a greater rate of change. Similar models, whether analysis of proportions or analysis of age, are represented on the same scale, which wire-frame reference guides help to quantify. Statistical significance of fitted models is represented by shaded discs, or lack thereof (nonsignificant). Negative trends have been inverted and projected upward for ease of visualization for age classes <35, 35–54, and 55–64 (negative).

ment age (65 and older); by 2050 the average age of farm and ranch operators will be 60—a 40% increase in age over operators from 1920. Although age classes and political units don't operate in isolation, these projections are cause for concern.

In general, the demographic trends in Wyoming mirror those seen across the country.[3] Although these patterns are fascinating academically, they ultimately point the way toward more important questions, such as: a) how do we ensure stability among the agricultural community and what will happen if we don't; b) how do we retain or attract young farmers and ranchers to the field; and c) if agricultural practitioners and their land disappear, how do we maintain sustainable, resilient landscapes? As farm and ranch operators grow older, we face a fundamental challenge in how to maintain their knowledge, wisdom, and ultimately, each community's cultural heritage.

Perhaps the greatest threat to agricultural landscapes that comes with an aging population of farmers and ranchers is that of land use conversion. The conversion of farmland stems from many sources and has been a consistent trend across the United States for decades.[9,10] In many parts of the country, farmers and ranchers feel that the lack of an heir is a primary reason to sell their properties.[11,12] For practitioners who do have interested heirs, the expenses associated with land transfer can become prohibitive—in the United States, farmers with a new inheritance often owe more in taxes than they have in liquid assets,[13] i.e., they might be land rich, but they are cash poor. These costs encourage landowners to sell property or equipment rather than pass their livelihoods down to the next generation. With fewer and fewer young farmers interested in, or financially capable of, taking over their family farms, many of Wyoming's aging operators may consider property sale as the one viable option as they transition away from the profession.

Although the sale of small family farms might promote a more corporate, professional style of ranching as large operations subsume smaller ones (discussed below), it is likely **t**hat many ranches and farms will be residentially or commercially developed. With development values far outweighing those of grazing or farming enterprises,[14] rural area development, especially in the Rocky Mountain states, has been increasing at an exponential pace.[15] Nationally, this form of "exurban" development has converted over 24 million acres of agricultural land to developed land in the 28-year period from 1982 to 2010[16]—an average rate of roughly 1.64 acres lost per minute! Exurban development affects not only our ability to produce food and agricultural products, but can, as the Western agricultural landscape becomes increasingly fragmented, dramatically impact many natural processes (e.g., plant succession, animal migration, subsurface hydrological flows, seed dissemination).[17] For Wyoming, the social implications of farmland loss extend to the wider state and regional

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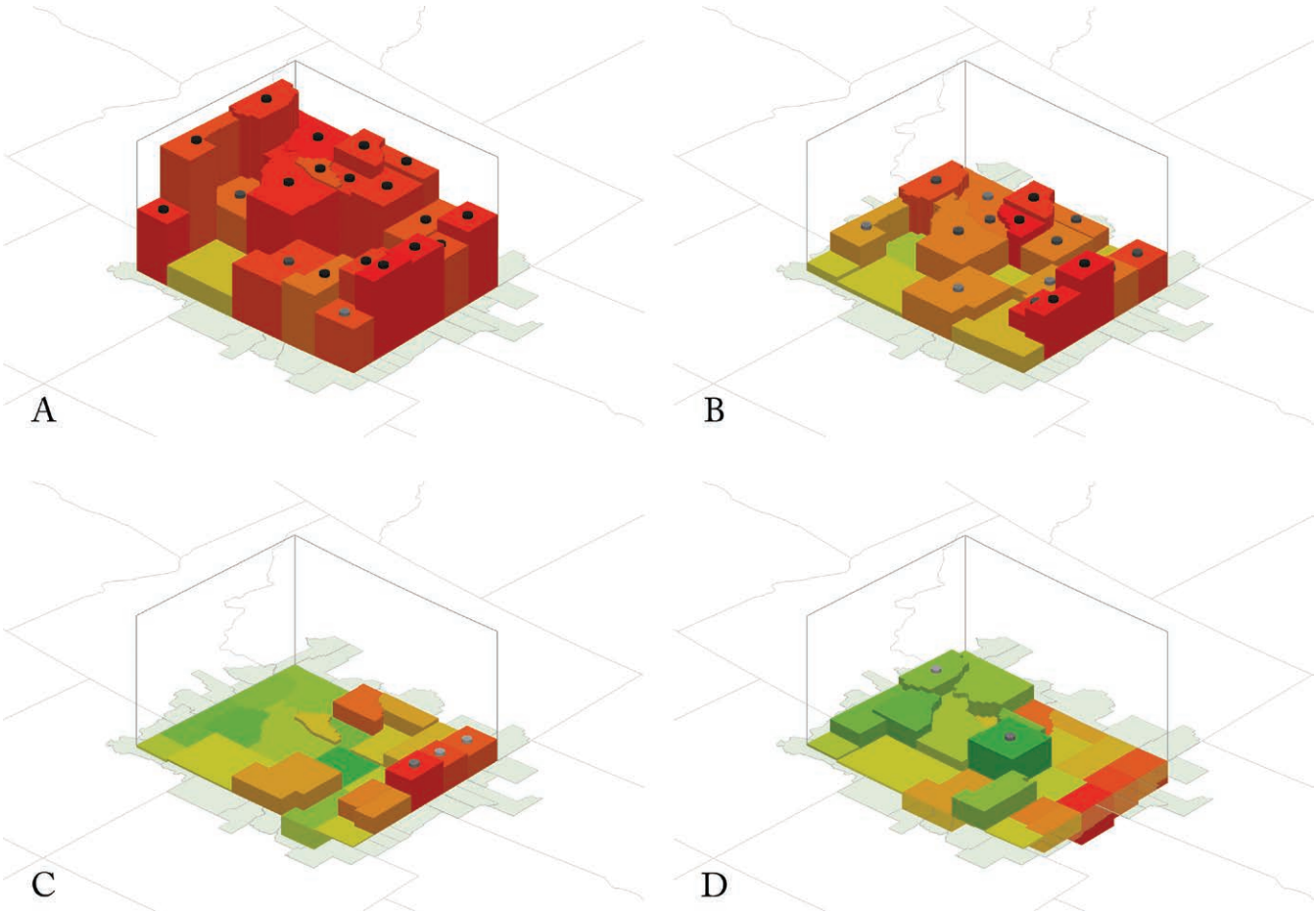


Figure 3. Trends in the relative proportions of farm and ranch operators between 1940 and 2007, as modeled through nonparallel multiple linear least-squares regression. Both positive and negative trends are projected upwards for ease of viewing. **A,** Negative trends for operators under the age of 35; **B,** Negative and positive trends for operators between the ages of 35 and 54; **C,** Negative trends for operators between the ages of 55 and 64; **D,** Positive trends for operators between the ages of 55 and 64. See Figure 2 for key.

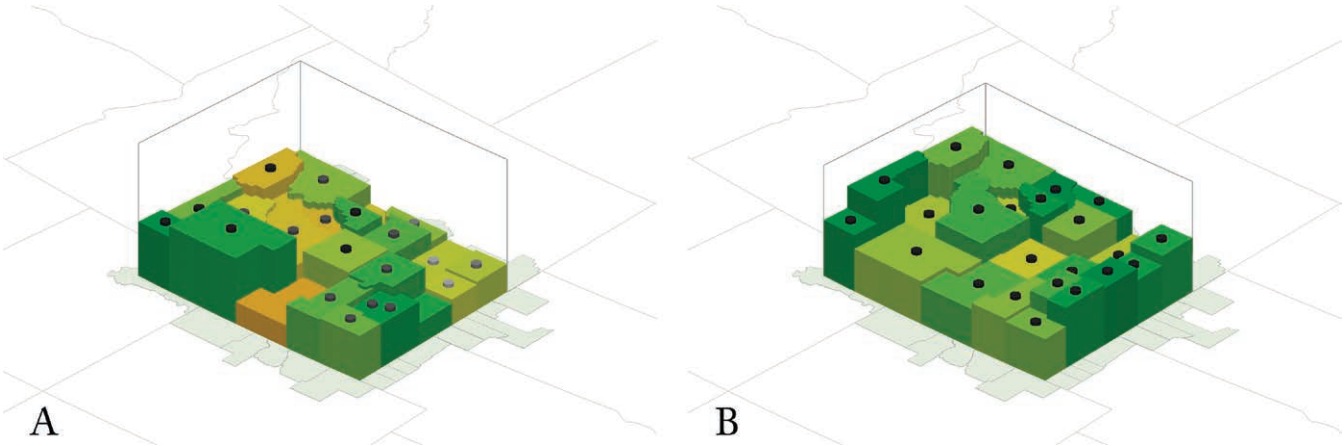


Figure 4. A, The positive trends in the relative proportions of farm and ranch operators ages 65 and greater, between 1940 and 2007, as modeled through nonparallel multiple linear least-squares regression. **B,** The positive trends in the average age of farm and ranch operators between 1920 and 2007, as modeled through nonparallel multiple linear least-squares regression. See Figure 2 for key.

communities. Wyoming has a long tradition of agriculture; since its earliest days it was a land of livestock operations and small homesteads.[18] Changes in agriculture are not inherently positive or negative, although implicit in a shift away from agricultural is a shift away from the state's roots and its cultural heritage.

The risk of land conversion is great, but an aging agri-social landscape bears additional risks associated with changes

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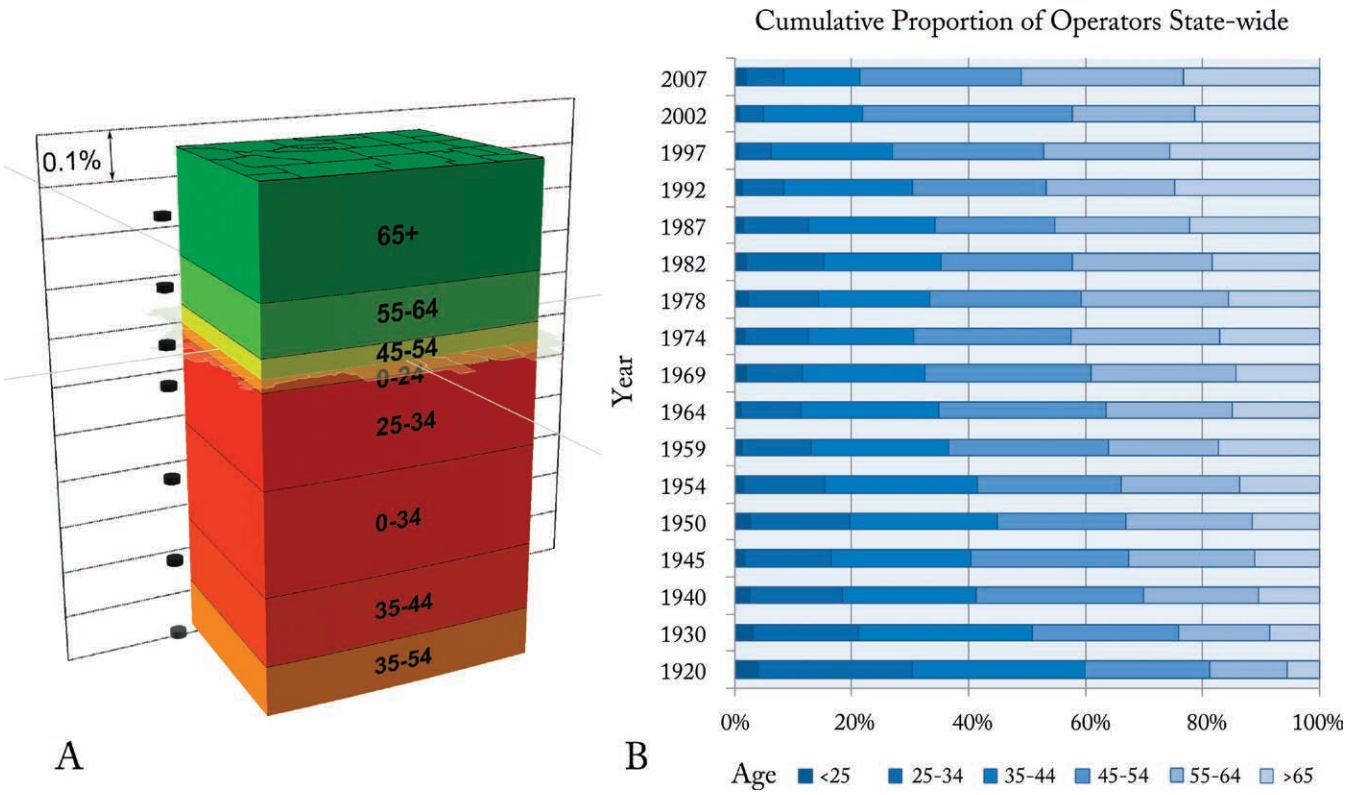


Figure 5. A, The positive and negative trends associated with state-wide changes in the proportions of farm and ranch operator age classes, as modeled through simple linear regression. Positive and negative trend extrusions are not cumulative; the order of age classes is arbitrary. See Figure 2 for key to all attributes except vertical scale (z-axis). **B,** State-wide cumulative proportions of farm and ranch operator age classes.

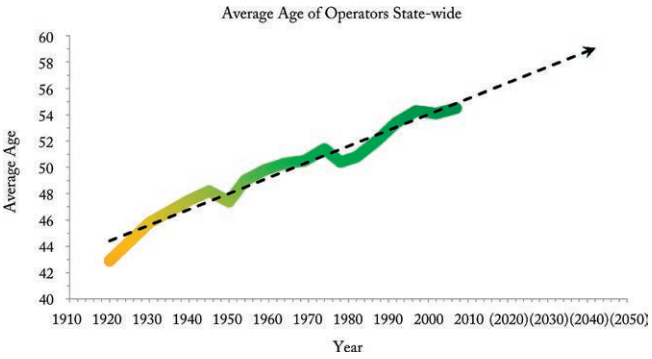


Figure 6. The positive trend associated with the average age of farm and ranch operators across Wyoming. Hue shades do not correspond to model strength, as in Figures 3–5A.

in local knowledge and management strategies. For enterprises that remain viable through time, the limited pool of young practitioners can lead to an increase in professional management.[6] Those who make farming and ranching their business might be brought in to provide expertise where younger generations have no time, interest, or investment, carrying both positive and negative repercussions. These rangeland professionals are often well educated in rangeland and livestock management, and can bring to the table a broader, deeper working knowledge of agricultural, environmental, or financial management techniques than the average family rancher.[19] In this way, the rise of professional management could be a critical factor in securing the future of farming and ranching, effectively buying time to engage younger generations of agricultural producers. However, while highly effective, professional land managers will be significantly less dependent on the local community[20] and their increased presence could lead to a dramatic loss of intimate local knowledge, loss of tradition, and loss of investment that stem from a deep-rooted sense of place. Agricultural wisdom, often built over generations, is irreplaceable once lost. Grazing practices finely tailored to the individual pasturelands, knowledge of local disease and pest cycles, water conservation strategies that work in tandem with local flora or geologic features, the understanding of decadal patterns of succession or regrowth—these are forms of place-based knowledge whose subtleties are carried by local operators and which might begin to fade if professional managers begin to dominate.

So how do we inspire a new generation of agriculturalists? In recent decades, Wyoming's economy has been largely supported by extractive industries (e.g., coal, coal bed methane, oil). For younger generations, the draw of these and other more profitable enterprises, often in metropolitan areas, is likely a source of migration away from rural landscapes and, by extension, away from agricultural enterprises.[6,21] Between the aging agricultural community, the lures of more lucrative business, and the loss of Wyoming farms—presently about half of the peak number in the 1930s[22]—it's clear that

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a multipronged approach to engaging the young is needed. Programs such as the Quivira Coalition New Agrarian Apprenticeship Program have been overwhelmingly successful in bringing a new generation of ranchers and managers up to speed with intensive practical learning in the field.[23] The Rural Landscape Institute, similarly, has developed an internship program[24] that gives young ranchers and farmers the ability to substitute field experience for classroom work, allowing concurrent pursuit of a bachelor's degree while developing practical expertise. These types of programs, when paired with government incentives (e.g., FSA loans, Environmental Quality Incentives Program, Conservation Reserve Program, Transition Incentives Program, tax breaks, crop and livestock subsidies) can be an important component in attracting new practitioners. Additionally, proper estate planning, including the use of conservation easements as an inheritance tool[19] can help to not only attract new farmers and ranchers, but allow family farms to continue passing from generation to generation. A variety of accessible resources are now available to help in this process, such as Land For Good's Toolbox for Farm Transfer Planning.[25] Proper planning can help stem the rapid rise in exurban development and preserve not just farming and ranching livelihoods, but ensure that agricultural landscapes remain intact to produce for the future.

The challenges of an aging agricultural community are intuitive and the mitigation strategies are tangible, but as we continue to wrestle with these changes we should not overlook less direct means of revitalizing and sustaining Wyoming's agri-social landscape. Environmental activist, author, and farmer Wendell Berry reminds us that "A deep familiarity between a local community and the local landscape is a dear thing, just in human terms. It's also, down the line, money in the bank because it helps you to preserve the working capital of the place."[26] Although many Wyoming natives take pride in their state lands, we might do well to consider how to cultivate that deep familiarity in young residents, such that regional agriculture can be supported from the bottom up through place-based ties and intimate connections to the landscape.[27,28] We can't expect the next generation of farmers and ranchers to sustain Wyoming's agricultural heritage and economy if they lack the ecological identities that engender strong relationships with the lands they are working.

Conclusions

Collectively, this research has emphasized major trends affecting those most directly tied to land-based livelihoods in Wyoming, and by extension, in the High Plains of the western United States. Where many local and regional conservation groups seek to engage these stakeholders in meaningful and productive ways, this work has provided direction and highlighted a sensitivity that must be employed when considering work with large-scale land management or land stewardship practices. Given the most recent "back to the land" enthusiasm that has swept the country in last decade, this is a time for optimism. Although past trends have not spoken favorably for the future of Wyoming's agriculture, we might be in midst of transition (e.g., National Young Farmer Coalition; USDA Beginning Farmers and Ranchers Development Program[29,30]). One benefit to Wyoming's abundant energy resources is the state's well-supported educational system, which provides highly subsidized schooling to local residents. This educational system is training new generations of critical thinkers, equipped with the tools and technologies that can make socially, as well as ecologically sustainable land management the norm. When the most recent (2012) census statistics become available, we might very well see a greater proportion of the younger generation investing in, and taking up stewardship in, healthy, productive, and resilient lives on the land.

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