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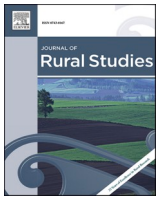

Exploring the relationship between regenerative grazing and Ranchers' wellbeing

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ABSTRACT

Regenerative grazing practices have garnered attention from researchers and practitioners as a promising approach for building farms' ecosystem health while also delivering societal benefits. While the ecological benefits of such practices have been extensively studied, their impact on farmers' wellbeing remains relatively unexplored but are as critical – we don't want to advocate for ecologically sustainable methods that decrease social wellbeing. This study contributes to this research gap by presenting and testing a novel framework to evaluate social wellbeing outcomes for farmers. Our framework provides a comprehensive operationalization of wellbeing, incorporating five distinct constructs identified in the literature. We translate the framework into a survey tool and use it to examine differences in wellbeing among beef producers using different grazing management practices in Michigan, USA. The survey was completed by decision-makers from 37 pasture-based beef farms - 16 regenerative, 19 transitioning to regenerative, and 10 not practicing regenerative approaches. Our findings underscore high levels of overall wellbeing across all participants, with particularly high scores for relational wellbeing and eudaimonic aspects. Furthermore, in line with previous research, we observed that regenerative producers exhibit distinctive values and perspectives towards farming, with differences in systems thinking between adopters and non-adopters of regenerative practices, with implications for wellbeing. We conclude that the survey tool successfully operationalizes social wellbeing in an effective way, and that by looking at wellbeing, values, and systems thinking together, the insights hold significant importance for supporting the wider adoption of regenerative grazing.

1. Introduction

Livestock production is facing significant challenges due to declining ecosystem health and increasing reliance on external inputs, which compromises the resilience of farms (i.e., against the market and extreme weather uncertainties) and impacts the wellbeing of producers (Jackson, 2022; Spratt et al., 2021). Saliman and Petersen-Rockney (2022) highlight the adverse effects of climate change and financial and emotional hardships on ranchers in the western United States, resulting in increased distress, anxiety, interpersonal tension, and alcohol consumption which have contributed to a decline in psychological wellbeing among this population. The shift towards conservation paradigms in recent decades has created opportunities for adaptive grazing practices, which offer a promising approach for building and regenerating farms' ecosystem health while also delivering societal benefits (Spratt et al., 2021).

Regenerative grazing, also known as adaptive grazing, is an approach that prioritizes soil health and adaptive livestock management principles to improve both human health - potentially improving nutrition and reducing the use of chemical inputs - and ecosystem health in livestock production systems by bolstering ecosystem functions (Newton et al., 2020; Spratt et al., 2021). This approach commonly involves maintaining short periods of intense grazing followed by long rest periods to support the paddock's recovery and build on the relationship between livestock and grassland (Teague and Kreuter, 2020). The literature on regenerative grazing has mainly focused on providing empirical evidence of the ecological benefits. Research has shown that regenerative practices can generate significant ecosystem services on and off the farm (Franzluebbers et al., 2012), providing opportunities for greater plant and insect species richness and birds (Goosey et al., 2019; Lwiwski et al., 2015; Lyons et al., 2017); improving soil structure and microbial communities (Glover et al., 2010; Teague and Kreuter, 2020);

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increasing water retention, water infiltration, improving soil fertility and preventing soil erosion (J. Y. Park et al., 2017; J.-Y. Park et al., 2017). Furthermore, regenerative grazing may significantly reduce a livestock grazing system's carbon footprint when compared with conventional grazing systems (Becker et al., 2022; Gosnell et al., 2020a; Stanley et al., 2018; Thompson and Rowntree, 2020) while providing sufficient feed for cattle weight gain (Fruet et al., 2019; Rowntree et al., 2020).

While the ecological benefits have been extensively studied, the societal ones received much less attention (Gosnell et al., 2020b; Spratt et al., 2021). The socio-economic benefits have been mainly financial, linked to biophysical benefits that diversified farming operations provide – i.e., the literature suggests that improvement in herd health is likely to reduce veterinary costs (Dumont et al., 2022; Gosnell et al., 2020a) and that multi-paddock grazing systems outperform continuous grazing systems in ecological function, which is predicted to feedback positively in ranching profitability (Gosnell et al., 2020a; LaCanne and Lundgren, 2018; Teague and Dowhower, 2022). However, the empirical evidence from regenerative farms is mixed. Alfaro-Arguello et al. (2010) show that holistic management (a decision-making framework that includes adaptive grazing management to improve land use, thus considered within regenerative grazing) can improve farms' sustainability but suggest it can be compromised by government assistance, particularly in cases where subsidies for input purchases do not lead to regional changes in the total energy or resources invested in the livestock system. Other research, such as Franke & Kotzé (2022), Hawkins et al. (2022), Windh et al. (2020) suggest that the impact of high-density grazing systems on farm productivity and profitability is inconclusive or may be negative due to higher labor, time, and infrastructure costs, as well as variability in animal weight. The contested results regarding socio-economic benefits call for research that can further the understanding of the benefits of regenerative grazing.

Despite farmers' wellbeing being a concern and motivation for promoting or assessing the effectiveness of regenerative practices, the discussion of the benefits of regenerative grazing has mainly focused on productivity and profitability. Research has shown that farmers adopt climate mitigation management practices, which overlap with regenerative practices, to pursue multiple benefits, such as reducing animal stress, enhancing their farm resilience to financial shocks and environmental conditions, reducing working time, and inheriting a healthy farm for the next generations, reflecting farmers' holistic thinking and how success is defined (Gosnell et al., 2020a; Mann and Sherren, 2018). As highlighted by (Gosnell et al., 2020b), for regenerative farmers, success is not just about financial gains, but also about improving their overall quality of life. Then, it is imperative to broaden the discourse on regenerative grazing to include its potential impact on the wellbeing of farmers.

The concept of human wellbeing has evolved during the last decades to encompass multiple factors, such as health, relationships, meaning, positive emotion, and the absence of anxiety, depression, and fear, which are viewed as important for optimal human functioning (Adler and Seligman, 2016). Within the regenerative grazing literature, there are some examples that link factors that can influence farmers' wellbeing with the adoption of these practices. Mann and Sherren (2018) describe that ranchers in the USA, Australia, and Canada report benefits such as quality of life, resilience, and social capital and identified managing crisis and desperation as factors why people were interested in training in adaptive grazing management. Barton et al. (2020) found that holistic management practices improved ranchers' communication with stakeholders and their confidence in handling difficult situations (e.g., droughts). Carien De Villiers et al., (2014) described that adaptive grazing practices enhanced social engagement and learning networks among ranchers in South Africa, and Derner et al. (2021) suggests that the value of adopting adaptive grazing management practices is how it changes the way ranchers manage the complexities of operating a ranch and rethinking their relationship with it. Interestingly, Gosnell et al. (2019) found that mechanisms such as social isolation, a sense of community, public recognition, and enthusiasm among others were influencing long-term commitment to regenerative or holistic management practices in Australian ranchers.

There is a growing recognition of the importance of social outcomes such as wellbeing in the assessment of regenerative grazing (Spratt et al., 2021). As previously mentioned, the literature has hinted at how regenerative grazing may impact farmers' wellbeing, however, few studies have explicitly measured the impact of regenerative grazing systems on wellbeing outcomes. In a study with those practicing extensive livestock grazing in Australia (and thus assumed to include those using regenerative practices), Brown et al. (2021) found that extensive practices were significantly correlated with subjective wellbeing measures such as life satisfaction, worthwhileness, the standard of living, personal health, achieving in life, personal safety, and community connectedness. Using the same 'Regional Wellbeing Survey' but from the following year, Brown et al. (2022) found evidence that managing extensive cattle and/or sheep grazing properties can increase farmers' self-efficacy and enhance their wellbeing and thus farmers' self-perception of how they manage their land can also lower their wellbeing. In a comparative study of Adaptive Multi-Paddock (AMP, a type of regenerative grazing), rotational, and conventional Canadian beef producers, Sherren et al. (2022) found that AMP producers have significantly higher levels of physical (health) wellbeing, while levels of financial, relational and psychological wellbeing were strong for all sub-groups. These studies certainly provide important insight into the positive relationship between regenerative grazing and wellbeing. Understanding farmers' wellbeing outcomes is therefore crucial to promote the adoption of regenerative practices.

This study aims to contribute to this emerging body of literature assessing the perceived benefits of wellbeing for regenerative farmers in the US, where no similar study has been conducted. We first highlight social wellbeing as a holistic concept and propose a novel framework for assessing multidimensional wellbeing, that integrates 5 key domains of wellbeing: (1) Life Satisfaction, (2) Hedonic, (3) Eudaimonic, (4) Relational, and (5) Physical Wellbeing (see Fig. 2 in Section 2.2.1 in methods) (although see below). Second, we pilot the framework to measure the social wellbeing outcomes of beef producers in Michigan, also exploring potential variations among different grazing management practices.

We argue that understanding the social wellbeing outcomes of regenerative agriculture techniques is as crucial as understanding the ecological impacts, as we need to ensure these methods maximize equity before scaling up adoption. Our results and discussion underscore the significance of relational and eudaimonic domains in the overall wellbeing of farmers and the implication of farmers' values and system thinking for their wellbeing. Tools such as ours allow us to ascertain that regenerative agriculture doesn't erode social wellbeing, and we can use insights from livestock producers on this topic to further justify the transition to regenerative farming systems that withstand environmental stressors while supporting the wellbeing of the farmers (Brown et al., 2021).

2. Materials and methods

Cattle operations in Michigan are relatively small compared to other regions in the United States. According to the Michigan Beef Industry Commission (2023), there were approximately 12,000 farms with beef (and dairy) operations that met 33% of the local meat demand and were valued at $541 million in 2022. While all Michigan cattle start life on pasture, the majority are finished in feedlot systems (>97%, Stanley et al., 2018). Feedlot finishing requires large proportions of agricultural land to be used for the cultivation of feed ingredients such as corn or alfalfa, with considerable use of chemical inputs that can lead to soil erosion and reduced productivity in the long term. Interventions to improve the system could include the adoption of regenerative grazing

practices and finishing on grass, which can reduce the need for chemical inputs and enhance soil organic matter content and soil health (Teague and Kreuter, 2020).

2.1. Study design

The study design was adopted from an interdisciplinary longitudinal research project on regenerative grazing of beef cattle in Michigan, USA (Hodbod and Raven, 2020). The methodological approach followed two main stages (1) recruiting participants and (2) the wellbeing survey design and implementation. This research was approved by the Michigan State University IRB Board through the Non-Committee Review procedure (STUDY00005404) on December 16th, 2020 and all participants provided informed consent before participating.

2.1.1. Recruitment and categorization

The recruitment and categorization by grazing system were iterative processes based on information from an online recruitment survey, in-person interviews, and on-farm observation, as shown in Fig. 1. An initial categorization as adaptive or non-adaptive (commonly slow rotation-continuous) was decided on given the interest in the broader project about how practices link to outcomes. Given Bork et al. (2021), Fenster et al. (2021), Teague et al. (2013), Teague & Barnes (2017) list adaptiveness as a core principle of regenerative agriculture and a feature that is assessable in a short survey, we focused our categorization of participating farms around adaptiveness.

An online recruitment survey was distributed widely to pasture-based beef producers during the winter of 2021 and spring of 2022 through the Michigan State University Extension, Michigan Cattleman's Association, and related networks. We received 98 responses, and 61 farmers were invited to participate representing a spectrum of grazing management practices ranging from non-adaptive (or continuous) to adaptive. The remaining 37 did not meet wider project needs for one of multiple reasons – no contact details, the herd size was too small (fewer than 10), no cow-calf operation (required for common enterprise), and/or they had not been running a grazing-based beef operation for at least three years. Some farmers also dropped out, so a final sample of 37 farms joined the project.

Their initial categorization was based on four questions, with the first three about practices (see Appendix A for full language of responses):

1. The grazing management style (0 = not movement, 1 = move based on time, 2 = move based on forage);
2. How often their cattle moved during a grazing season in an average rainy year (0 = no rotation to 7 = multiples times a day)
3. How long the cattle were in a paddock (0 = all season to 7 = less than a day).

The responses to those three questions were summed and the criteria for categorization were defined as adaptive if the score was $\geq$ 12 and non-adaptive otherwise. The adopting group was defined by a fourth question - whether the farmer considered their practices to be regenerative/adaptive and had managed the land in such a way for at least 5 years. If a farmer's score was greater than 12 but has less than 5 years, it was classified as adopting, similarly if a farmer's score was less than 12 but they consider their practice regenerative, it was also classified as adopting.

Fig. 2. Social Wellbeing Framework. Our framework identifies five key domains related to wellbeing: (1) Life Satisfaction, (2) Hedonic, (3) Eudaimonic, (4) Relational, and (5) Physical Wellbeing. An additional description is offered in the methods section.

The initial categorization was revised after a phone or Zoom interview that took place in the Spring of 2022. During the interview, farmers were asked for more details about their grazing management to add context to the initial classification questions collected in the recruitment survey. A final adjustment to the categories was made after in-situ observation of farmers' grazing practices in the summer of 2022.

After the second classification, we categorized 45 farmers from the 37 farms (that were either the sole or joint primary decision makers) into three groups: first, the adaptive group (n = 16) which includes those farmers who were practicing regenerative grazing with their beef cattle at the time of the recruitment; second, farmers in a transition process towards regenerative grazing (n = 19), and finally a group of non-adaptive farmers (n = 10).

2.2. Survey design

2.2.1. Theoretical considerations for the subjective wellbeing survey

The wellbeing survey offered a holistic operationalization of social wellbeing as subjective wellbeing (SWB), acknowledged as an adequate

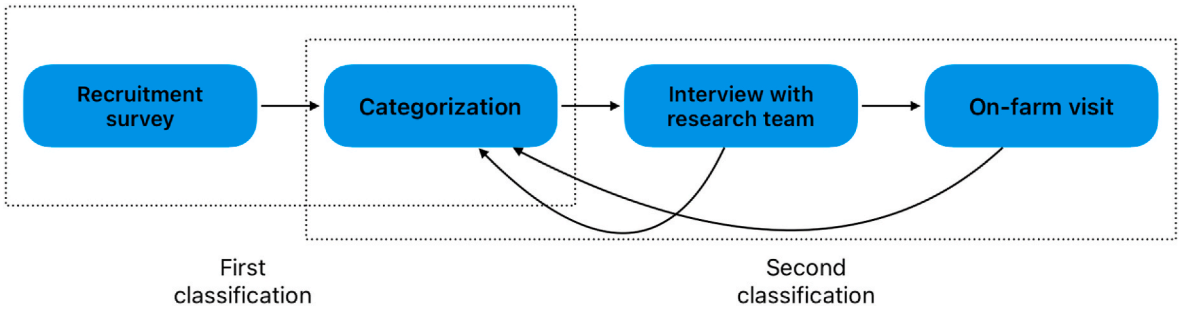

Fig. 1. Farmers categorization process.

measure of human wellbeing (Frey and Stutzer, 2014). The research on operationalizing SWB has evolved beyond positive and negative affect to one that considers thriving across multiple domains in life. Therefore, we consider social wellbeing as a latent variable measurable through the outputs in multiple domains of subjective wellbeing. We propose a novel measure for social wellbeing integrating five existing different domains or constructs (Fig. 2): (1) Life Satisfaction, (2) Hedonic wellbeing, (3) Eudaimonic wellbeing, (4) Relational wellbeing, and (5) Physical wellbeing. From this perspective, maximizing one's human experience – social wellbeing – is viewed as maximizing one's experience in all of the five domains mentioned above.

A central assumption in our framework is that although all domains are intrinsically related, they are understood as independent constructs that influence the optimal human experience. Hedonic wellbeing (HWB) was originally described as the affective evaluation of people's lives as positive or negative (Bradburn, 1969) and the cognitive components of one's life conditions (Cantril, 1965). However, empirical evidence has shown that these dimensions are separable (Davern et al., 2007; Deci and Ryan, 2008). Achieving the optimal human experience goes beyond happiness or positive and negative affect (Butler and Kern, 2016) including living as one was inherently intended to live, which is best known as eudaimonic wellbeing (Deci and Ryan, 2008). Relational wellbeing rests on the premise interpersonal relationships, such as socializing or social support, influence human wellbeing (Adler and Seligman, 2016; Biddle et al., 2019). Hence, what is often evaluated in relational wellbeing is the social network or availability of social interactions and the satisfaction with received support and giving support to others (Butler and Kern, 2016; Winefield et al., 1992).

Within the wellbeing literature, and particularly in economics, there has been an interest in objective indicators of wellbeing. These indicators are based on the resources and opportunities people may access and how well people meet their needs (Breslow et al., 2016; de Maya Matallana et al., 2022; Gilbert et al., 2016; Loveridge et al., 2020). Our interpretation of physical factors followed Costanza et al. (2007), where objective indicators are viewed as a means to potential improvement in subjective wellbeing. In our framework, we framed objective indicators as physical wellbeing and included two sub-categories – an evaluation of the physical and mental health and financial conditions of farmers. The literature suggests that poor physical and health conditions diminish sujective wellbeing (Gilbert et al., 2016; Tang et al., 2021); conversely, better financial conditions positively affect the level of subjective wellbeing by increasing consumption level and the capacity to deal with illness or unemployment (Easterlin et al., 2010; Fernández Domínguez and Hernández, 2019; Frey and Stutzer, 2014; Mahendru, 2021; Voukelatou et al., 2021).

Although connected, the uniqueness of the domains calls for a holistic measure of social wellbeing. Therefore, our novel framework makes a distinction between each of those components and the survey asked about four subjective wellbeing domains and for a subjective evaluation of those often called "objective" measures, or physical wellbeing.

2.2.2. Scales/Instrument selection

The literature on wellbeing provides a substantial number of well-developed scales that each measure a particular construct of wellbeing, such as the Satisfaction with Life Scales (Diener et al., 1985), Positive and Negative Affect Schedule (Watson et al., 1988), or the Ryff Scale for eudaimonic wellbeing (Ryff, 1989). There are also a few that integrate multiple constructs, for instance, the PERMA-Profiler (Butler and Kern, 2016), the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS, (Stewart-Brown et al., 2009), the Flourishing Scale (Diener et al., 2010), or The Stanford WELL for Life Scale (Heaney et al., 2017). A limitation of these scales is that they focus on either two or three domains of wellbeing, but more practically is that they often are of considerable length, like the 160-question Stanford WELL for life scale, requiring significant time and risking participant fatigue. However, these scales offer two main advantages: they are grounded in theory and have been widely validated.

Three validated scales were selected to represent the five elements of social wellbeing in our framework in the survey. The main criteria for selecting the instruments or scales were theoretical validity, statistical reliability, validity, and the time required to complete the instrument. They are described below and the specific questions used are presented in Appendix B, along with which wellbeing element they relate to.

2.2.2.1. Life satisfaction – satisfaction with Life Scales (SWLS). To measure life satisfaction, this survey relied on the Satisfaction with Life Scale (SWLS; (Diener et al., 1985). This 5-item scale measures the individual cognitive components of subjective wellbeing,. Responses range from 0 (strongly disagree) to 6 (strongly agree), where higher scores indicate higher levels of life satisfaction. SWLS has been found to be correlated with socio-economic and health variables and has high reliability and validity (Adler and Seligman, 2016; Cheung and Lucas, 2014; Frey and Stutzer, 2014; Tang et al., 2021).

2.2.2.2. Hedonic, eudaimonic, and relational wellbeing – PERMA-Profiler. PERMA-Profiler is a multidimensional measure of wellbeing. This scale includes 15 questions that measure five subdomains: Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment (Butler and Kern, 2016). Moreover, the scale includes eight additional questions that assess negative emotions and a subjective evaluation of physical health. The questions are evaluated on a scale from 0 (low level) to 10 (high level). The subdomains have shown cross-time stability, high internal consistency, and a high correlation with other wellbeing scales such as the Ryff scales, which suggest the trans-theoretical characteristic of PERMA-profiler and its capability to measure hedonic and eudaimonic constructs of wellbeing (Cobo-Rendón et al., 2020; Giangrasso, 2021). PERMA-Profiler allowed us to measure three of the domains of wellbeing in our framework - hedonic (positive and negative emotions), eudaimonic (engagement, meaning, and accomplishment), and relational (relationships) - in a more streamlined way compared to choosing individual instruments.

2.2.2.3. Physical wellbeing. To assess the physical health domain of physical wellbeing, we used the PERMA-Profiler as described above. The scale also included a set of questions for self-evaluation of physical health, aligning with our goal to evaluate this "objective" domain from a subjective standpoint. Additionally, we added a mental health question inspired by the physical health question in the PERMA-Profiler. For the subjective evaluation of financial conditions, we included a set of four questions inspired by the work of Sherren et al. (2022).

2.2.3. Social wellbeing index

An important steps in analyzing social wellbeing is determining how to communicate the results of different scales. Constructing an index served as a practical approach to presenting the collected data. We combined the scores of the five social wellbeing constructs into a single index, with each construct having equal importance. The construction of the social wellbeing index required normalizing (rescaling) the data, as the instruments in our survey used different response scales. Normalizing the data attempts to give all constructs equal weight. Min-max normalization, also known as min-max scaling, involves linearly transforming the data to fit within a smaller range, such as the [0, 1] range. Following (Han et al., 2022) min-max normalization rescales x_i, of construct Z to $x_i^{'}$, in the range of $[new\_max_Z, new\_min_Z]$ by computing:

$$x_i^{'} = \frac{x_i - min_Z}{max_Z - min_Z}\left(new\_max_Z - new\_min_Z\right) + new\_min_Z$$

Where $x_i^{'}$ is the normalized value and x_i is the original value for the Z construct. It is important to note that to preserve the scale's original nature, the min and max values correspond to the min and max values of

the scale rather than the data recorded for each item in any scale. We then calculated the average of the normalized scores $x_i^{'}$ of each construct to obtain a final index with range [0, 1]. Values closer to 1 denote higher scores in each of the 5 constructs of social wellbeing, indicating that one's human experience is being maximized.

2.2.4. Additional survey sections

Understanding which factors may accelerate (or block) the adoption of new agricultural practices is crucial. Previous research on the adoption of regenerative grazing has indicated that aligning agricultural practices with farmers' values and motivations is a crucial aspect of decision-making (Gosnell et al., 2020b). Given this perspective, along with framing wellbeing as living within one's values (Wallace et al., 2021), we deemed it important to assess farmers' values. Additionally, understanding and managing fundamental systems processes play a critical role in enabling effective management to address uncertainty and complexity, especially in practices like regenerative grazing (Gosnell et al., 2020a,b, Mann and Sherren, 2018).

The survey also included questions we created on information support and networking (to supplement PERMA's relationships section), as well as standard demographic questions such as age, educational level, and income (given their influence on wellbeing (Costanza et al., 2007; de Maya Matallana et al., 2022; Gilbert et al., 2016; Jivraj et al., 2014; Kristoffersen, 2018; Tang et al., 2021).

2.2.4.1. Human values. Values can be understood as guiding principles that shape individual or group decision-making, attitudes, and behavior (Schwartz et al., 2012), and thus important to understand the adoption of agricultural practices. Farmers' values were assessed using the Short Schwartz Value Survey (SSVS) with demonstrated internal consistency and temporal reliability (Lindeman and Verkasalo, 2005). The SSVS assesses the 10 motivationally distinct values that are theoretically derived from Schwartz's value theory: Power, Achievement, Hedonism, Stimulation, Self-Direction, Universalism, Benevolence, Tradition, Conformity, and Security. These values can be grouped into two parts: Openness to Change versus Conservation and Self-enhancement versus Self-transcendence. Participants were provided with a brief description of each value and asked to rate their importance ranging from 1 (against my principles) to 7 (of supreme importance).

2.2.4.2. System thinking. System thinking is often recognized as a crucial competence for understanding how systems work and change. We built upon the work of Sherren et al., (2022) and included a 9-item System Thinking and Traditional Thinking Scale. Each item was rated in a scale ranging from 1 (strongly disagree) to 5 (strongly agree).

2.2.5. Survey implementation

The survey was designed and implemented using Qualtrics. The survey consisted of closed-ended questions providing respondents with pre-determined answer options. The survey was served online and sent through emails (collected in the recruitment survey) to 45 farmers in Michigan, identified as the main (or joint) decision-makers for the 37 participating farms during the recruitment process, during the spring and summer of 2022. The majority of participants completed the survey by themselves online, with an expected completion time of 17 min. Given some technology or connectivity issues, some answered the survey during a phone/Zoom call, where the lead author ran through the questions and entered their answers. All responses were collected in approximately 8 weeks. Data cleaning and statistical analysis were conducted in the software R version 4.2.1. (R Core Team, 2022). Participants received a summary of their individual results that Fall.

3. Results and discussion

This section discusses the exploratory analysis of the wellbeing survey. The socioeconomic data collected shows that the farmers' groups are comparable in certain characteristics, such as age, education, race, and marital status. The average age of farmers was within the 35-44-year-old range for all groups, with a bachelor's or professional (MA, MS, MBA, PhD, JD, MD, DDS, etc.) degree, mostly Caucasian, and 87% of farmers were married. In terms of yearly income, the adaptive group reported the lowest levels but had a bimodal distribution ($25,000-$49,999 and $75,000-$99,999), the non-adaptive and adopting groups reported considerably higher levels of income, $75,000-$99,999 and $150,000 or more, respectively. However, differences in proportions between groups were not statistically significant.

3.1. Wellbeing outcomes

Table 1 shows the five domains considered in our multidimensional measure of social wellbeing, along with the classical internal consistency measure cronbach's alpha for each domain. Cronbach's alpha is a measure to describe the degree to which items within a scale measure the same construct. The test score range from 0 to 1 with acceptable scores from 0.70 to 0.95 (Tavakol and Dennick, 2011). The life satisfaction, hedonic, eudaimonic, and relational wellbeing domains showed acceptable Cronbach's alpha scores, however, the score for physical wellbeing was questionable. Tavakol & Dennick (2011) describe that low alpha scores can be due to a limited number of questions, weak connections among items, or heterogenous constructs. When computed independently, Cronbach's alpha scores for physical health and finances questions were 0.85 and 0.70, respectively, which suggest that poor inter-relatedness may be the reason for the low score for physical wellbeing. Since conducting an alternative reliability analysis (such as confirmatory factor analysis) was not possible due to our small sample size we decided to keep both sub-dimensions as part of the physical wellbeing construct and flag this as an areas for further study. Moreover, we did modify the relational wellbeing construct. Originally the PERMA scale measures relational wellbeing using three questions: *to what extent do you receive help and support from others when you need it? How satisfied are you with your personal relationships?* and *to what extent do you feel loved?* However, we found poor inter-relatedness between the first and the other two questions and thus we only kept the last two questions to build the relational wellbeing construct. This suggests that for farmers in this study, relational wellbeing was more about the support received from their family relationships and less about social networks, hence we did not integrate social network data from that survey section.

As observed in Table 1, overall, farmers scored higher in relational wellbeing, followed by eudaimonic wellbeing and physical wellbeing as the three highest categories. This suggests that farmers are highly satisfied with their accomplishments, social support, health, and finances. When farmers were asked in a follow-up question which domains of wellbeing were most important to them, all groups consistently ranked relationships and purpose and meaning (eudaimonic wellbeing) as the first and second most important domains.

We then computed a correlation matrix to observe the strength of the relationship between constructs to assess divergent validity (see Table 2). In general, we observe that the strength of the correlation between the constructs was low to moderate and in the expected direction considering our theoretical expectations. Surprisingly,

Table 1
Wellbeing constructs and overall index.

Wellbeing constructs	Mean	Sd	Cronbach's Alpha
Life Satisfaction	0.76	0.14	0.79
Hedonic Wellbeing	0.71	0.13	0.82
Eudaimonic Wellbeing	0.80	0.11	0.75
Relational Wellbeing	0.86	0.14	0.79
Physical Wellbeing	0.77	0.11	0.03
Social WB Index	0.78	0.10	0.84

Table 2
Correlation matrix.

	Life Satisfaction	Hedonic Wellbeing	Eudaimonic Wellbeing	Relational Wellbeing	Physical Wellbeing	Social WB Index
Life Satisfaction	1.00					
Hedonic Wellbeing	0.64	1.00				
Eudaimonic Wellbeing	0.58	0.50	1.00			
Relational Wellbeing	0.54	0.46	0.39	1.00		
Physical Wellbeing	0.64	0.59	0.56	0.42	1.00	
Social WB Index	0.87	0.81	0.74	0.73	0.75	1.00

relational, eudaimonic, and physical wellbeing showed the lowest correlation with the social wellbeing index. Despite having similar levels of variability in their scores, life satisfaction and hedonic wellbeing had the strongest relationship with the index. In other words, farmers with a high social wellbeing index were more likely to score high in life satisfaction and hedonic measures, even though the farmers self-identify relational, eudaimonic, and physical constructs as the main contributors to their wellbeing (see Table 1). Our initial thought was the effect of the support received from their interpersonal relationships was expressed as the absence of negative emotions (anxiety, sadness, and anger) and the presence of positive ones (joy, contentment, and positivity) captured through hedonic wellbeing. However, the correlation matrix did not indicate a strong relationship between the scales used to measure these domains. A more plausible explanation is that the relationship between relational wellbeing and the social wellbeing index is not fully captured by our estimation approach, in other words assigning equal weights to each category to create the index does not reflect the farmer's understanding of "relationships". Further research with larger sample sizes and alternative reliability analyses could provide additional insights into the multidimensional nature of social wellbeing.

Table 3 displays the scores for the five constructs and the social wellbeing index, along with the results of multiple pairwise comparisons. Our objective was to determine whether any of the groups scored significantly different from the others for any of the wellbeing constructs, including the social wellbeing index. It is imperative to acknowledge, however, the inherent limitations stemming from the small number of participants that limits generalizability of the findings and increases statistical variability. Further research efforts are encouraged to build upon these preliminary findings, incorporating larger and diverse samples to enhance the robustness and applicability of the insights from our study. However, given the exploratory nature and specific purpose of this study, our analyses still provide valuable initial perspective for understanding the relationship of grazing practices and wellbeing. Considering the limitation of our sample size, we compared the differences among the three groups of farmers using the post-hoc non-parametric Dunn test since it is an appropriate option when the ANOVA assumptions of equal variance or normal distribution are not fulfilled (Dinno, 2015). Moreover, p-values were adjusted to control for the family-wise error rate (FWER, rejecting the null hypothesis when it is true) using Holm's correction.

It can be seen from the data that all groups score strongly, indicating high levels of wellbeing across beef producers in Michigan. Non-adaptive farmers generally scored higher in all constructs compared to the adapting and adopting groups, with the largest differences observed in life satisfaction between non-adaptive and adopting (−0.09), relational wellbeing between non-adaptive and adaptive (−0.1), and overall social wellbeing index (−0.07). Similar results were observed in Brown et al. (2021) and Sherren et al. (2022). However, despite these differences, none of them were found to be statistically significant, except for the difference in social wellbeing index between the adaptive and non-adaptive groups was borderline significant at 90% level (p-adj = $0.11 < 0.10$). Despite there being no statistically significant difference, it is interesting to observe the variation in the ranges of min and max values for each group and discuss this in the view of the theory of subjective wellbeing homeostasis. Cummins et al. (2003) and Cummins & Wooden (2014) suggests "homeostasis" as an analogy to explain why the mean values for subjective wellbeing metrics in the western world are about 75% of the scale score, arguing that subjective wellbeing is "actively controlled and maintained" with a form of steady-state affective set-point. Thus, this implies that we would observe little variation if people's homeostatic systems are normally functioning.

Considering Cummins' theory, we could ask what is the "set-point" around which social wellbeing variations are interesting to interpret despite their non-statistical significance. Looking at the prior cited literature, we observe that subjective wellbeing scores for farmers in Brown et al. (2021, 2022), Sherren et al. (2022) were in a range of 70–80% of the scale's maximum scores used on those studies. Such values are consistent with what we observed for the adaptive and adopting groups but not for the non-adaptive ones. There could be two possible scenarios. The first one is that the non-adaptive farmers' higher scores in all constructs reflect their current homeostatic state, where they have adapted to their existing circumstances and have found a way to maintain their overall social wellbeing, presumably linked to a long-term consistency in grazing technique, given they are using 'traditional' practices and have not or are not adopting new agricultural practices. Conversely, an alternative scenario may suggest that the adaptive and adopting groups may be going through a period of adjustment due to the adoption of new practices. We assigned farmers to the adaptive group if they had been using such practices for at least 5 years, but realistically this is a short period to adopt new practices in agriculture. Therefore, participants in these groups may well still be undergoing temporary disruption of their homeostatic equilibrium. This suggests that there may be some differences in social wellbeing between the adaptive and non-adaptive groups related to the adoption of regenerative grazing, but more data would be needed to confirm this.

Given the purpose of this study, it is important to highlight that our results indicated that the social wellbeing of all groups of farmers falls within a range typically associated with a healthy state of wellbeing. Moreover, while adoption of new practices may be influencing social WB, it is not significantly eroding it and thus we encourage the continued scaling up of regenerative grazing practices in Michigan's beef sector.

3.2. *Values and system thinking results*

Previous research has described how farmers who embrace regenerative approaches often exhibit distinct values and perspectives towards farming, and the importance of systems thinking in the adoption of regenerative grazing practices (Sherren et al., 2022; Gosnell et al., 2019). The results of Schwartz's value scale in Table 4 showed that across the sample, farmers rated more highly for the values of Self-direction, Benevolence, Universalism, and Conformity, while the lowest ratings were for Power and Hedonism. These findings are consistent with what Sherren et al. (2022) observed in Canada. The Self-direction scores suggest that farmers generally trust their own abilities. The high scores in Benevolence and Universalism, which belong to the Self-transcendence dimension, suggest that farmers show a high concern for others' wellbeing. This can be linked to the results of relational wellbeing discussed earlier. When we asked farmers what they considered to be the main measure of success on their farms, family

Table 3
Wellbeing and farmers' groups.

	Life Satisfaction	Hedonic Wellbeing	Eudaimonic Wellbeing	Relational Wellbeing	Physical Wellbeing	Social WB Index
Non-adaptive	0.82	0.74	0.83	0.89	0.83	0.82
Adaptive	0.75	0.69	0.78	0.79	0.76	0.75
Adopting	0.73	0.71	0.79	0.82	0.75	0.77
Pairwise-comparison (p-value -adjusted)						
Adaptive - Adopting	0.44	1.00	0.63	0.79	0.76	0.44
Adaptive - Non	0.51	1.00	0.22	0.14	0.17	**0.11**
Adopting - Non	0.20	0.73	0.38	0.13	0.12	0.33

there is no evidence that differences in mean between groups are statistically significant.

Table 4
Values and system thinking.

Scales	Mean	SD
Schwartz's Values		
Social power, authority, wealth - Power	3.04	1.31
Success, capability, ambition, influence on people and events - Achievement	4.93	1.14
Enjoyment in life, self-indulgence, gratification of desires - Hedonism	4.07	1.62
Daring, a varied and challenging life, an exciting life - Stimulation	4.78	1.26
Creativity, freedom, curiosity, independence, choosing one's own goals - Self-direction	5.89	0.86
Broad-mindedness, beauty of nature and arts, social justice, a world at peace, equality, wisdom, unity with nature, environmental protection - Universalism	5.71	1.12
Helpfulness, honesty, forgiveness, loyalty, responsibility - Benevolence	6.27	0.58
Respect for tradition, humbleness, accepting one's portion in life, devotion, modesty - Tradition	4.96	1.38
Obedience, honoring parents and elders, self-discipline, politeness - Conformity	5.27	1.01
National security, family security, social order, cleanliness, reciprocation of favors - Security	4.96	1.15
System Thinking		
I like to have a well-defined goal for my operation, and make decisions that bring me closer to it	4.24	0.68
I try to make management decisions so that my operation can mimic nature as much as possible	4.36	0.88
A healthy farm is self-sustaining and needs few inputs to be profitable	3.89	0.98
My management decisions have a big impact on the local ecosystem and community	3.86	1
Everything on my operation is connected, and even small decisions can have cascading effects in unpredictable way	4.29	0.76
Traditional Thinking		
A successful farmer concentrates on production and is not sidetracked by outside interests or activities	2.36	1.17
At a landscape level, decisions are made elsewhere, so my choices don't have a huge effect	1.78	0.77
Economic viability overrides all other farming considerations	2.42	0.99
We may not be able to solve every problem yet, but science and technology will eventually offer a solution for every problem	2.44	0.97

Human values can be grouped in four categories: (1) Self-enhancement: Power, Achievement, Hedonism; (2) Openness to change: Hedonism, Stimulation, Self-direction; (3) Self-transcendence: Universalism, Benevolence; (4) Conservation: Tradition, Conformity, Security (See Schwartz et al. (2012)).

ranked first, while participating in the community ranked last. We interpret the importance of family relationships in the lives of farmers as a reflection of the socio-cultural structure within US agriculture, where success is deeply intertwined with familial bonds, i.e., that the intrinsic role of family and relational wellbeing supports their overall wellbeing. But the survey results also showed that consistent with the high self-transcendence scores, the low scores in Power and Hedonism values (part of Self-enhancement) indicated that farmers focus less on themselves, perhaps because they focus more on the family unit. Simultaneously, conformity scores indicated that traditional values (e.g., honoring parents) are highly regarded among farmers. Of course, this intricate relationship between values, relational wellbeing and the overall wellbeing of farmers is difficult to understand with only statistical information, so further qualitative exploration is required to understand further how values are connected to wellbeing.

Table 5 shows the Cronbach's alpha results for values and system thinking constructs. The results indicated that only the self-enhancement category had an acceptable Cronbach alpha. Considering that our sample size (n = 45) is sufficient for a reliable estimation of Cronbach's alpha,[1] we argue that the low internal consistency does not necessarily rule out unidimensional in the values items, and further examination with a larger sample size and factor analysis may be necessary to assess the issues with the reliability and dimensionality of the other constructs for the Michigan beef population. Nevertheless, the results in Table 5 support the previous discussion and underscore the significance of values such as benevolence, which emphasizes the importance of closer relationships to farmers.

The results in Table 6 show that, as expected, the adaptive and adopting group of farmers scored lower in self-enhancement and conservation values at the aggregated level, suggesting farmers' motivation to challenge traditional practices (Schwartz and Cieciuch, 2021). The pairwise comparison for the self-enhancement revealed that only the difference between the adopting and non-adaptive groups was statistically significant (P-adj = 0.05). These results implied that farmers transitioning to regenerative grazing are less motivated than non-adaptive farmers by the desire to gain wealth, social power, or personal success.

The results of the pairwise comparison of system thinking and traditional thinking scales were also expected given similar results in Sherren et al. (2022) and reflect regenerative grazing's philosophy of holistic management (Gosnell et al., 2019, Mann and Sherren, 2018) or natural resource management (Brown et al., 2022) and of managing 'the system'. As seen in Table 6, the average scores for system thinking were higher for the adaptive and adopting group although only the difference between adaptive and non-adaptive groups was found to be statistically significant (p-adj = 0.09 < 0.1, applying Holm's adjustment). On the other hand, the non-adaptive farmers scored statistically significantly higher than the adaptive (p-adj 0.03 < 0.05) and adopting groups (p-adj = 0.01 < 0.05) for traditional thinking. Given, how those questions were

Table 5
Values and system thinking constructs.

	Cronbach alpha
Group of Values	
Self- enhancement (group 1)	0.63
Openness to change (group 2)	0.47
Self-transcendence (group 3)	0.43
Conservation (group 4)	0.54
Thinking framework	
System thinking	0.53
Traditional thinking	0.47

[1] See Bonett (2002) for a discussion on sample requirements.

Table 6
Comparison of values and system thinking among groups of farmers.

	Self- enhancement	Openness to change	Self-transcendence	Conservation	System Thinking	Traditional Thinking
Non-adaptive	4.77	4.97	6.00	5.53	3.76	2.75
Adaptive	3.98	4.81	5.97	4.96	4.29	2.19
Adopting	3.65	4.96	6.00	4.89	4.20	2.04
Pairwise comparison (p-value adjusted)						
Adaptive - Adopting	0.33	1.00	1.00	0.91	0.50	0.53
Adaptive - Non	0.26	0.91	1.00	0.21	**0.09**	**0.03**
Adopting - Non	**0.05**	1.00	0.96	0.16	0.21	**0.01**

framed (see Sherren et al. (2022)), these results suggest that non-adaptive farmers may focus on individuals or segmented components of their operations, while farmers that adopt or are using adaptive or regenerative grazing practices are more likely to consider the complex interrelationship between various components of their farming systems when making management decisions.

As suggested by Sherren et al. (2022) in order to understand farmers' management choices, it is important to understand how they interact with their farms. The results of our exploratory analysis suggest that adopting regenerative grazing practices may encourage farmers to rethink their relationship with their farms (also discussed by Sherren et al. (2022)). For instance, the statement "*I like to have a well-defined goal for my operation and make decisions that bring me closer to it*" was the highest rated among adopting farmers. These changes in farmers' thinking may ultimately lead to better management decisions that can positively impact their wellbeing. However, further research is needed to determine whether adopting regenerative grazing practices leads to a shift in farmers' thinking or whether farmers who are already inclined to think more holistically are more likely to adopt regenerative grazing practices in the first place. A further investigation of farmers wellbeing over time could shed light on the complex relationship of regenerative grazing and social wellbeing outcomes.

4. Conclusions

Regenerative grazing practices offer a promising approach to enhancing the ecological health of farms while also providing societal benefits. This study contributes to the literature by emphasizing the significance of examining the social wellbeing outcomes among regenerative pasture-raised beef producers in the United States. By adopting a holistic approach to social wellbeing, we developed and tested a novel framework to investigate the differences between regenerative and non-regenerative farmers in Michigan, USA. Our findings reveal high levels of wellbeing among all beef producers in our sample, with relational wellbeing and eudaimonic domains playing a pivotal role in farmers' overall wellbeing. Although we didn't find significant differences between groups of farmers, we argue that even small differences observed in social wellbeing are important and further research should delve deeper into these differences, considering the theory of the homeostatic state of wellbeing in Western countries (Cummins et al., 2003), particularly within farmer populations.

Additionally, we examined the link between values and wellbeing and found that adopters of regenerative grazing scored higher in values that prioritize caring for the family as a guiding principle influencing decision-making. Moreover, consistent with previous research and regenerative grazing philosophy, regenerative farmers demonstrated a strong inclination towards system thinking; this seems to indicate that managing regeneratively by understanding 'the whole', requires certain values. However, to uncover the causal relationship between values, system thinking, and the decision to adopt regenerative grazing, future studies should consider longitudinal approaches.

The insights derived from this research can help tailor extension programs and policy development supporting the transition towards regenerative practices. For example, extension programming can be tailored for those with different values, perhaps focusing on relational values for those whom maintaining the farm for future generations is important. Additionally, policy could encourage the long-term monitoring of social and ecological wellbeing, acknowledging the importance of both for a resilient farming system.

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CRediT authorship contribution statement

Jonathan Vivas: Conceptualization, Data curation, Formal analysis, Methodology, Software, Validation, Writing – original draft. **Jennifer Hodbod:** Conceptualization, Funding acquisition, Methodology, Project administration, Supervision, Writing – review & editing.

Data availability

Data will be made available on request.

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Appendix A

Table A.1
Recruitment questions – Adaptiveness

Question	Response Set
Which grazing style is most similar to how you graze your beef cattle?	The cattle have access to all available pasture(s) throughout the year (0); The cattle are moved between different pastures throughout the grazing season based on time (1); The cattle are moved between different pastures throughout the grazing season based on forage health and recovery (2)

(*continued on next page*)

Table A.1 (*continued*)

Question	Response Set
In a fairly average rain year, how often are the cattle moved during the grazing season?	Blank (0); Every 2-3 months (1); Once a month (2); Twice a month (3); Once a week (4); Two or three times a week (5); Every day (6); Multiple times each day (7)
On average, once cattle are moved to a particular grazing unit (i.e., paddock), how long are they there for?	All season (0); Multiple months (1); A month (2); Multiple weeks but less than a month (3); A week (4); Multiple days but less than a week (5), A day (6); Less than a day (7)

Appendix B

Table B.1
Wellbeing construct and questions.

Construct	Question	Response Set	Reference
Life Satisfaction	In most ways my life is close to my ideal The conditions of my life are excellent I am satisfied with my life So far, I have gotten the important things I want in life If I could live life over, I would change almost nothing	0 (strongly disagree) to 6 (strongly agree)	SWLS (Diener et al., 1985)
Hedonic Wellbeing	In general, how often do you feel joyful? In general, how often do you feel positive?	0 (Never) to 10 (Always)	PERMA - Profiler (Butler and Kern, 2016)
	In general, to what extent do you feel contented?	0 (Not at all) to 10 (Completely)	
	In general, how often do you feel anxious? In general, how often do you feel anxious? In general, how often do you feel sad?	0 (Never) to 10 (Always)	
Eudaimonic Wellbeing	How often do you become absorbed in what you are doing? How often do you lose track of time while doing something you enjoy?	0 (Never) to 10 (Always)	
	In general, to what extent do you feel excited and interested in things? In general, to what extent do you lead a purposeful and meaningful life? In general, to what extent do you feel that what you do in your life is valuable and worthwhile? To what extent do you generally feel you have a sense of direction in your life?	0 (Not at all) to 10 (Completely)	
	How much of the time do you feel you are making progress towards accomplishing your goals? How often do you achieve the important goals you have set for yourself? How often are you able to handle your responsibilities?	0 (Never) to 10 (Always)	
Relational Wellbeing	To what extent do you receive help and support from others when you need it? To what extent do you feel loved? How satisfied are you with your personal relationships?	0 (Not at all) to 10 (Completely)	
Physical Wellbeing	In general, how would you say your health is? Compared to others of your same age and sex, how is your health?	0 (Terrible) to 10 (Excellent)	
	How satisfied are you with your current physical health? How satisfied are you with your current mental health? *	0 (Not at all) to 10 (Completely)	
	Compared to 5 years ago, I am financially better off now Looking at the future, in 5 years I expect my financial situation to improve My financial situation is a constant source of worry Regardless of what happens, I have made choices that will help me be financially	0 (strongly disagree) to 6 (strongly agree)	Sherren et al. (2022)

Note: * The mental health question is an addition inspired by the physical health question in PERMA-Profiler.

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