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Soil health and well-being: Redefining soil health based upon a plurality of values

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ABSTRACT

The dominant research paradigm for soil health emphasizes instrumental values to achieve sustainable food systems. However, soil provides a plurality of values in society beyond instrumental value contributing to human well-being. This research aims to understand the relational values that soil provides farmers by examining the meaningfulness and intrinsic motivation for building soil health among wheat farmers in the Inland Pacific Northwest (iPNW). Data were collected from two soil health work sessions and 11 in-depth semi-structured interviews with innovator wheat farmers to understanding broader perspectives and meanings of soil health. Four themes of relational values emerged from the data showing the link between soil health and human well-being. The results suggest that the term soil health should not be exclusively assessed by its instrumental values but also by its relational values supporting a plural valuation of soil health. Incorporating soil health's plural valuation into research will contribute to more effective holistic innovations supporting human and environmental well-being. This research provides important insights into defining soil health and for transforming the innovation paradigm of soil health to include relational values and cultural ecosystem services for transforming our current food system into an equitable, sustainable, healthy, and just system. Changing soil health assessments to acknowledge additional soil health management outcomes related to human well-being may facilitate decision-making, support the intrinsic motivation of soil health, and provide support to transformative food systems.

1. Introduction

Building an equitable, just, sustainable, and healthy food system is a complex and dynamic challenge. The three main agro-innovation paradigms are efficiency, demand restraint, and food system transformation (El Bilali et al., 2019). An agro-innovation paradigm is the dominant framework of social norms in the research community, defining the problem of focus, the acceptable methods, and the breadth of acceptable solutions for transforming the food system to build a sustainable future. Soil science falls within the efficiency paradigm. Currently, soil science innovations aim to improve environmental quality while also increasing economic viability and agricultural production to transform our food systems (Peña, 2017; Tilman et al., 2011). Therefore, innovations only promote soil health's instrumental values, neglecting, and marginalizing non-instrumental values of soil health (Ellis et al., 2019). For example, the absence of the concept of psychological well-being from the soil health for human health conversation (Brevik et al., 2020). Instrumental values of soil are the unilateral flow of the benefit from soil to humans to improve human well-being (*e.g.*, nutrient cycling, plant available water, and pollutant degradation) (Alcamo et al., 2003).

Developing innovations that only advance instrumentally valued outcomes simplifies the multi-dimensional social outcomes of the food system, neglecting the non-material human well-being aspects of agriculture, which leads to their degradation (National Research Council, 2003; Niles et al., 2018; Stefanovic et al., 2020). We argue that by ignoring the relational and plural valuation of soil health, soil science does not effectively address the dynamic and complex societal challenges linked to creating a sustainable food system. The Nature's Connection to People (NCP) framework proposed by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) advances the ecosystem services framework by stating that values are pluralistic and are determined by cultural models (Díaz et al., 2018; Ellis et al., 2019; Pascual et al., 2017). NCP recognizes that the relationships humans have with nature across cultures and contexts require a more nuanced understanding of the types of values beyond instrumental valuation (Ellis et al., 2019). And that power differentials between stakeholders

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determine which values of nature are pursued and promoted within the dominant agro-innovation paradigm (Arias-Arévalo et al., 2017).

There is a diversity of values related to nature (Kenter et al., 2019). Nature is valued pluralistically beyond just instrumental values, depending on cultural models or diverse world views (Pascual et al., 2017). Intrinsic values exist outside of the value placed on nature by humans (e.g., diversity of soil types). Relational values are the benefits derived from a caring relationship with soil by an individual or a community. arew are a multi-directional flow of benefits from individuals and communities to the soil, and vice versa through soil stewardship (Chan et al., 2016; Pascual et al., 2017). Farmers have intrinsic and relational values for soil derived from their stewardship and care for the soil (Keith et al., 2016; Puig de la Bellacasa, 2015; Tironi et al., 2020). Relational values of soil stewardship are the base of indigenous or traditional ecological knowledge. However, due to the systematic imperialism of indigenous knowledge by soil science, these values have been erased. This is compared to the exploitative western perception and concept of land ownership (Peña, 2017). Relational values, a concept taken from indigenous knowledge (Gould et al., 2019), conceptually advances the poorly defined term cultural ecosystem services, which is seen as a unidirectional flow of benefits from nature to humans (Daniel et al., 2012; Ellis et al., 2019; Himes and Muraca, 2018).

1.1. Defining soil health

A working definition of soil health is the soil's ability to function and provide for the well-being of humans, plants, and animals (Kibblewhiteg et al., 2008). These include attributes, such as soil organic matter, soil pH, nutrient levels, and the prevalence of pests versus beneficial organisms, as well as physical properties, such as soil depth, compaction, and water infiltration. Soil health assessments are typically done through a combination of on-farm measurements and sending samples to commercial labs for chemical and biological measurements. Importantly, there is no single measurement that captures what factors make soil healthy; different regions and land-use histories will have different soil properties that limit plant productivity and ecosystem services.

While the importance of different indicators varies, many studies track a soil's progression towards being healthy through collecting soil samples from specific land areas under varying aspirational conservation practices and comparing these to nearby "business as usual" soils. Identified aspirational soil conservation practices explored in the literature include no-till (Nunes et al., 2018) and cover crops (Stewart et al., 2018). In addition, nearby "undisturbed land" (Maharjan et al., 2020) may provide a baseline of what a potentially healthy soil looks like in a specific region and may help define the potential range of a system. The act of defining the baseline or the range of a potential system is a valued act. For example, choosing "undisturbed land" as a baseline neglects the thousands of years of continued sustainable indigenous soil and land stewardship (Peña, 2017).

Soil health assessments need expansion to also focus on how the user of the soil health assessment will use it to make decisions, and their needs and motivators for behavior change (Lobry de Bruyn and Abbey, 2003). For example, indicators that can show annual progress of soil health improvement (Karlen et al., 2017, 2019). Other suggestions include reformulating soil health assessments to fit within the existing routine of farmers and require minimal paperwork and limited training (Lobry de Bruyn and Abbey, 2003). Soil health measurements are currently an area of high research activity, so ways of involving growers in research and co-innovation activities can serve to empower them.

1.2. Motivation and adoption of soil health

Motivation can be both intrinsically and extrinsically influenced (McClelland, 2005), and is affected by values (Stern et al., 1999). Scholarly literature has examined extrinsic monetary and policy determinants for encouraging pro-environmental behavior. There is limited widespread adoption of conservation practices with current extrinsic motivation leverage tools (Napier, 2010). However, this lack of progress may be related to neoclassical economics' difficulty in capturing assigned values related to non-material human well-being (Wegner and Pascual, 2011). More knowledge is needed to understand soil health behavior determinants to increase conservation behavior (Baum and Gross, 2017). Several frameworks examine the relationship between environment, assigned values, behavior, environmental governance, and management (Arias-Arévalo et al., 2017; Ellis et al., 2019; Schulz et al., 2018; Stern et al., 1999).

Humans are intrinsically motivated by the pursuit of their own well-being and fulfillment of their psychological needs (Deci and Ryan, 2008, 2012, Maslow, 1943, 1954; Tay and Diener, 2011). The concept of well-being varies across cultures although some patterns of well-being are cross-cultural (Blackstock, 2011; McCubbin et al., 2013; Tov and Diener, 2009). Indigenous peoples perceive a strong connection between relational values with mother nature and their well-being (Gould et al., 2019; Peña, 2017). The non-indigenous conceptualization of intrinsic motivation has been dimensionalized as autonomy, competency, and relatedness (Deci and Ryan, 2008, 2012). Differing frameworks of well-being provide variants on the broad typologies. For example, the indigenous derived Breadth of Life Theory recognizes cognitive, physical, spiritual and emotional dimensions (Blackstock, 2011). The millennium assessment (MA) framework of ecosystem services and human well-being recognizes five components of well-being beyond material need: freedom, choice, health, personal security, and social relations (Alcamo et al., 2003). Maslow's hierarchy of needs uses five broad categories that motivate behavior: physiological, safety, love and belonging, esteem, and self-actualization (Maslow, 1954, 1943). Needs and motivations are not hierarchical as related to pursuing well-being, and multiple needs can motivate a single behavior, depending upon the individual, culture, and context (Maslow and Frager, 1987; Paavola and Adger, 2005; Tay and Diener, 2011).

The management of agricultural soil is determined by the farmer and/or landowner assigned values. The determination of soil's assigned value by farmers beyond economic profitability remains under-explored in the literature (Himanen et al., 2016). Ecosystem valuation by farmers is determined by culture, context, and perceived nature connections (Allen et al., 2018; Vignola et al., 2010; Wuepper, 2020). Efficacy of soil health hinges on identifying and understanding the plurality of assigned values of soil, as well as how the power of agency relates to the expression of valuing soil by marginalized communities (Allen et al., 2018; Arias-Arévalo et al., 2017; Braito et al., 2020).

Farmers have diverse values that motivate their soil health management behavior, ranging from connectedness to soil, freedom, and authority (Braito et al., 2020). Limited research has examined motivators in under-represented farmer groups, such as women and beginning farmers (Barnes and Bendixsen, 2017). The prioritization of values and how they are applied varies by group (Ellis et al., 2019; Schulz et al., 2019). Care, often attributed to women, is a motivator for community and pro-environmental oriented farming practices (Jarosz, 2011; Wells and Gradwell, 2001). Women play an important role in determining the adoption of pro-environmental soil health practices in the United States (Bridges and Napier, 2003). A case study with urban African American farmers in the southern United States documented the pursuit of well-being, the embodiment of femineity, and the nurturing of Mother Earth as critical motivators for women to pursue farming (Barnes and Bendixsen, 2017). More research is needed to understand the prioritization of values across farmers related to the assigned value of soil health and its relationship with human well-being.

This research has a transdisciplinary objective by working between the social and soil sciences to identify additional assigned values of soil health by commodity wheat farmers and crop advisors in the inland Pacific Northwest (iPNW). This research aims to advance soil science theory and paradigm surrounding how soil health is defined and therefore

assessed using social science theory and methodology. We argue that soil health needs to be contextually defined and assessed by the user of the soil health data and that solely relying on predetermined soil biological, chemical and physical characteristics do not holistically evaluate the plurality of value types soil health provides to human well-being. Additionally, this work seeks to fill the knowledge gap of relational values associated with soil health. Currently, soil science focuses on instrumental values of soil for human well-being. By developing a greater understanding of the plurality of the soil health's value has across contexts, we can more effectively improve human well-being through soil science innovation. Radical change in the soil science paradigm is necessary to advance our goals of sustainable food systems. The research presented here includes equal representation of female farmers within the study sample to gain a representative understanding of soil health and its connection with well-being. Specifically, our research question is: What does the concept of soil health mean for farmers as it relates to the pursuit of their own well-being?

2. Methods

Qualitative research provides a critical methodological gap to understanding adoption and the barriers to the adoption of soil management strategies (Lobry de Bruyn, 1999; Prokopy, 2011) (Lobry de Bruyn, 1999). Qualitative research is founded on epistemological and ontological differences from natural science that have limited past transdisciplinary research for solving societal challenges related to soil management (Howard and Lawson, 2015). Integration of multiple stakeholder knowledges may create trust with science, create meaning for science across society and contextualize scientific results. The integration of multiple stakeholders' knowledge may be limited by epistemological and ontological differences, giving privilege to the dominant majority or scientific perspective due to a power differential and poor best management practices in stakeholder engagement (Reed, 2008). Qualitative research collects non-numerical data sources in systematic ways. One aim of qualitative research is to understand and explore the phenomenon in question. The aim is not to understand the degree that the phenomenon exists in society or if it is generalizable (Charmaz, 2014). Best management practices in qualitative research ensure rigorous science (Bernard, 2000). Qualitative research uses several different techniques to indicate the quality or rigor of the research, including triangulation, prolonged engagement with the population, member checking, peer reflection, rich thick description, discrepant information, and clarifying researcher bias (Patton, 1999).

2.1. Context

The iPNW spans across the western portion of Washington State, northern Idaho, and the northwestern corner of Oregon. Wheat is the dominant crop on more than 5 million dryland acres in the iPNW (Schillinger and Young, 2004). Both winter and spring wheat varieties are grown in the iPNW in diverse cropping systems across a large variety of soil types and precipitation zones that vary over a steep gradient (150–640 mm annual precipitation) due to the rain-shadow of the Cascade mountains. Soil health practices in the region include reducing or eliminating tillage, planting cover crops, using crop rotations to enhance soil fertility, and suppressing weeds and disease. In 2017, 25% of all farm operations in Washington over 500 acres practiced no-till, and 43% practiced conservation tillage (USDA, 2017).

2.2. Design

A case study research design aims to develop a holistic understanding of a particular outcome of a context (Bernard, 2011). This research is designed to understand the meaning underlying innovator wheat farmers in the iPNW adoption of the concept of soil health. The aim is not to have generalizable results that can be replicated. Rather, this design aims to develop an understanding of why innovator farmers adopted the concept of soil health. This may give insight into the missing intrinsic motivators behind soil health and provide a holistic understanding of soil health outcomes that may assist soil health assessment across environmental and social indicators. Innovator farmers in the context of this study are those who recognize the importance of soil health and are exploring and implementing various new practices to enhance the health of their soils despite the potential financial risk (Rogers, 2010). Data were collected through two forms: two work sessions (five hours each) and 11 semi-structured interviews.

2.3. Data Collection and Analysis

Two five-hour work sessions, a format with elements of both a workshop and focus group, with 23 and 20 participants, respectively, were conducted using the liberating structures methodology. The work sessions explored self-motivation related to soil health, soil health innovation opportunities, and identified social capital within the region to promote soil health innovation. The work sessions' aim was to create an innovation platform to spur future research directions and opportunities. The work sessions were funded by the Washington State Soil Health Initiative Seed Grant. All participants granted informed consent. A mixture of farmers, state agencies, researchers, and private companies were represented. The workshops were audio recorded. Notecards from the activities, synthesis conclusions by the groups, and evaluations were collected. Audio-recordings were spot-transcribed during pertinent discussion moments due to audio quality.

Selected workshop participants were contacted to ask if they would like to participate in follow-up interviews to discuss the social dimensions of soil health. Selected participants were asked to participate based on expressing non-economic and non-external motivators for pursuing soil health, for example, the importance of creativity and the embodiment of Christian behavior in managing soil health. Snowball sampling was used to identify women commodity wheat producers to participate in the research (Bernard, 2011). Women producers are often excluded from social science research surveys (Rosenfeld, 2017). It became clear from initial interviews that their missing perspective was essential to pursue and explore. All participants granted informed consent. In total, 11 semi-structured 1-2 hour interviews were conducted with white farmers and consultants—five female producers, four male producers, and two male crop consultants. All participants self-identified with soil health. Two of the female producers were beginning farmers in their first year of production as an operator. All other participants had been involved with wheat production for several decades. Sampling ended due to identifiable women producers during the onset of COVID-19 lockdowns and the beginning of the spring season. Interviews were conducted via phone, Zoom, at producers' homes, or in public spaces, with the audio being recorded and then transcribed. Transcript quality was checked and corrected by the interviewer.

The semi-structured interviews were an inductive process during which the interview guide evolved as the data were preliminarily analyzed before the next interview (Charmaz, 2014). Data collection and analysis happened hand-in-hand and evolved to explore new, emergent themes from the participants. The semi-structured interviews were focused on understanding how and why farmers attribute meaning to the concept of soil health. There was a focus in the interview guide to understanding meaningfulness of soil health to the producer. Meaningfulness is understood to be a form of deep intrinsic motivation (Chalofsky and Krishna, 2009; Ward and King, 2017). Questions such as, "What does soil health mean to you?" and "What does soil health mean to your community?" were asked to probe into the intangible well-being and intrinsic motivators for adopting the concept of soil health.

Transcripts were coded in MaxQDA 20.2.2 with content analysis (Bernard and Ryan, 2010). All coding and data analysis occurred by the first author. Data derived emergent codes from the interview transcripts were inductively categorized under themes and then super themes re-

Table 1
Data analysis codebook.

Super themes	Themes	Codes
Self-actualization	Fulfilling potential and objective	Goal, passion, hope, tool for measuring progress toward a goal, self-challenging, important, motivation, morale, enthusiastic, excited, hope, interesting, fulfilling, hope, identity, feels good, happy, rewarding
	Learning and creativity	Learning, reflection, creativity, smarter, experimentation, fascinating, risk, search for knowledge, new innovations, awareness, knowledge, ignorance, out of the box, systems thinking, mindfulness, growing, skill, boredom, new challenges, fun
Esteem	Dignity and pride for livelihood	Social status, gratitude, trust, world citizen, pride, transparency, social symbol of crop valuation, arrogance, confidence, humbling
	Respect in the farming community	Landlord acceptance, role model for behavior change, social norm, neighbor cooperation, generational conflict, social value, farmer community, reputation, leadership, social symbol, good farmer, stigma
Connectedness	Social learning and peer belonging	Inclusive, farmer support group, collaboration, encouragement by peers, influence by peers, no social community, social connection, social capital, social learning
	Rebuilding rural communities and food systems	Rebuilding food system, food security, repopulating rural communities, rural social capital, change agent for the food system, helping the community, part of the community, communities not commodities, societal well-being, rebuilding rural communities, reengaging public in agriculture
	Stewardship, nurture, and care	Stewardship, care, nurture, consciousness, connectedness to soil, family safe, gender discrimination, reverence for intrinsic soil value, femineity suppressed, love for the soil, two-way relationship with soil, serving soil, healer, apologizing to soil, scared duty, greed, mimicking nature, the value of soil
Self-determination	Gaining control by working with nature	Control over production, reducing synthetic inputs, supporting natural systems, utilizing natural systems, resiliency of production system, harmony with nature, domination and control over nature, killing nature, foundation, holistic interconnectedness with nature, regenerative
	Freedom, autonomy, and flexibility	Autonomy, control over product price valuation, change agent, land tenure, self-sufficiency, flexibility, control over product value, resiliency, control over production, enslaving, freedom, liberating, control over inputs, balance
	Farm viability	Risk, costs, labor, future potential, soil is livelihood, income, policy support, productivity, efficiency, debt, marketability
	Physical and mental health	Mental health, pesticide residues, physical health, quality of life, stress

lated to dimensions of well-being (Table 1) (Deci and Ryan, 2012; Maslow, 1943, 1954). One participant provided a member check by providing feedback on the accuracy of representing their lived experience of the results (Bernard, 2011). Indicators of quality used in this research include community engagement, triangulation of workshop and interview data, member checking, the inclusion of codebook, peer reflection, rich thick description with the use of quotes, and discrepant information of when themes were not unanimously expressed by all participants (Patton, 1999).

3. Results

The results are divided into four dominant well-being themes that emerged from the workshops and interviews expressing how soil health provides them relational values and meaning: self-actualization, esteem, connectedness, and self-determination. Farmers saw soil as an essential part of supporting their well-being and the well-being of their communities. The results explore intrinsic motivation and the meaning of soil health.

3.1. Self-actualization

The farmers expressed self-actualization through the adoption of soil health. Two themes emerged that expressed the farmers' self-actualization through soil health: fulfilling potential and objectives, learning, and creativity solving problems.

3.1.1. Fulfilling potential and objective

Soil health provided a goal for the farmers to work toward. "Soil health is an important thing that we're trying to foster and achieve, as much as it is an objective, and it's a goal, " said participant 2. Farmers embodied these goals and objectives so much that it became part of their identity.

> It (soil health) is very important to me, probably more than to some of my neighbors or friends. Something that I've been interested in and have developed a passion for. So it (soil health) is just part of who I am, that I want to do that. Participant 10

Furthermore, fulfilling this potential and reaching these goals and objectives made farmers feel good. "Being able to focus and feel good about what you're doing," said participant 9.

3.1.2. Learning and creativity

Farmers noted that it was fun and exciting to learn about how to improve soil health by experimenting and problem-solving in their field, as well as by observing and mimicking nature. The progress they saw in improved soil health gave them motivation to continue farming and continue learning and experimenting. Participant 1 said, "It is exciting and makes farming fun."

> I think seeing it (soil health) progress from what it was to what it's becoming is really motivating. And seeing I have some part in the transformation, I think it's really cool to see the progression. And that really motivates me, and I've been wanting to figure out a better metric where I can, like, kind of establish this baseline and then you know, measure how far it's (soil health) come. I haven't really figured that out yet. I think the growth and transformation is really motivating. Participant 2

Farmers perceived problem-solving as an essential part of achieving their goals and that they were solving larger societal, wicked, or difficult to solve problems of the food system. Participant 3 explains how solving the problem of soil health is about embracing a different perspective and a new way of tackling day-to-day challenges.

> Instead of waking up every day and going, what am I going to kill today? What am I going to spray?... Instead, you say, what am I going to plant today? To feed my soil? Whole different thing. It really is a whole different thing. It's fun. It's fun to think about it. And it's, you know, I mean, there is a piece that's kind of nerve-wracking about what did we set in motion with what we did last year? I don't know. I've been walking. I have my suspicions. Yeah. And nothing seems

too insignificant, but we're still learning. And so, you know, there's a piece where it's like that's a challenge because it's like what do I need to learn today so that I can understand this a little bit better? Participant 3

Farmers saw they could change the food system that they are part of and become a leverage agent for positive change. Further, the ability to be that leverage agent was important for self-fulfillment.

So really diversifying our systems and looking at other ways of really making that system work. That is what's got me excited right now is I think we had a breakthrough in our understanding of what needs to be done. Participant 9

Most participants expressed that the current soil testing options did not enable them to measure progress or reflect upon changes they were experiencing in their soil, which perpetuates the power and knowledge gap between scientists and farmers' practices in their fields. After one workshop, one farmer and consultant pulled out their soil test results of phospholipid fatty acid (PLFA) profiling of fields that have been in cover crops and examined the results with researchers. After examining and discussing the test results' inconsistency, they collaboratively concluded that the expensive test results were not scientifically advanced enough to accurately represent the changes in the farmer's soil resulting from his adoption of cover crops.

For farmers, farming is more than a career. Farming is a livelihood and lifestyle. Soil health gives them a focus, goal, target to aim towards, be curious about, and continuously learn about. Soil health provides a means to self-actualization for the farmers to make advancements and progress throughout their lifetimes.

However, not all learning always ended in positive results that built motivation. "These young bucks they get in there, and they get on all enthusiastic over it (soil health), but when the results don't show up right, then it's dampening their enthusiasm a little bit," said Participant 1.

3.2. Esteem

Soil health is a means for farmers to improve their esteem through improving their perceived dignity in society, their respect within the farming community, and to give them the freedom and flexibility to take control of their farm.

3.2.1. Dignity and pride for livelihood

Negative messaging surrounding food quality, pesticide use, and environmental impacts of farming have impacted the perceived dignity and respect farmers receive from society. Soil health provides a means of communicating and receiving respect for their choices in livelihood and hard work.

I actually had a very good friend that just really offended me. So bad. I was so mortified. I couldn't believe it. It is really hard to find help [to work on the farm]. My friends and I had gone to Mexico for a girl trip, and we were in the airport. Getting ready to leave. And there was this really nice bartender, he was younger, and I just said, oh my gosh, I would love to bring you home and have him work on the farm for us, or with us. She [friend] looked at me [and said] 'Well, that job is below him.' And I wanted to just smack her. Because I thought that is what I do every day, and it's below him? So what do you think of being a farmer? It made me so sad and so upset. What I do for a living is looked down upon by people… People actually think that farmers, you're dumb, or demeaning job. Little do they realize that that's the food they put in their mouth. I mean, we feed them. Participant 8

At the end of the day, these [farmers] are the people that probably care most about that (environmental protection)… It is important to have recognition. The recognition that we're providing a better product to them. Participant 9

However, farmers are currently limited in their ability to receive respect and dignity from society because there is little available scientific evidence to support that healthier soils result in a higher quality of food.

If I can get our soils turned around to where we're actually producing a healthier, denser product and have a way of proving that or showcasing that. I don't know, I think the sky's the limit. I mean, I really personally believes that that's what the consumer wants. It's just how can we get it there? How can we prove it to them? Participant 4

3.2.2. Respect in the farming community

In addition to gaining dignity in society for their livelihoods, soil health is a means for farmers to gain respect within their peer farming community.

My husband's family's reputation, they're known as good farmers. And they haven't done anything necessarily like, you know, outstanding or like noteworthy. They don't get awards for it, right. [However,] You go to conferences, and people say, 'I know you guys. You are really good farmers.' And that's humbling and nice to see and nice to hear. Legacy probably means different things to different people, but I think like if it can mean like good stewardship, if it reflects your good stewardship of that land, I think that's a noble thing to go after. Participant 2

Esteem is built by how we perceive being respected and our ability to control our own destiny.

Soil health supported and gave farmers esteem. By adopting soil health, the farmers perceived dignity within the food system, confidence that they were making the right decisions, recognition of value by the public and by other farmers, an increase in their social status within the innovator farmer social group, and power to make changes in their livelihood. Soil health gave them the confidence to continue adopting new agronomic practices and empowerment to make positive changes that improve their livelihood.

3.3. Connectedness

Social learning and the potential to support and regrow rural communities enable farmers to find belonging within their peer groups and in their larger communities. Soil health is a way for farmers to connect to their land and show their love for the resource, and as a result, they feel positive reciprocity for their stewardship. Finally, allowing for the nurturing aspects of agriculture provides balance to the domination of conventional agriculture.

3.3.1. Social learning and peer belonging

Soil health provides a crucial non-competitive topic to foster social learning and provide a sense of belonging for farmers by drawing them together in peer learning groups.

There's a lot of collaboration among farmers… it just kind of helps you feel like you're part of a larger group with similar values. That always makes you feel good… To be able to share information and experience reaffirms that we're going after similar things, and we can contribute to that greater knowledge and experience pool. Participant 2

In addition, Participant 2, 4, and 9 belong to an invitation-only farmer group that supports self-funded, self-run research across multiple farms for exploring alternative agricultural inputs and soil health practices. The goal of the group is to learn about bio-farming.

3.3.2. Rebuilding rural communities and food systems

There is considerable hope that soil health and improving soil health can be a critical leverage point for rebuilding rural communities and being a food system change agent. Being part of a larger, stronger rural

community also provides a sense of belonging in the agricultural landscape. Participant 9 said, "People are starting to do this type of agriculture, regenerative Ag., and they're rebuilding a community. They're getting people reengaged in agriculture."

> And by maintaining the health of the soil, we hope to leave it more productive for future generations… Farm sizes have increased. And so it takes a bigger farm under current farming conditions; it takes a bigger farm to sustain a family. The same farm size once sustained several families. And so if we could get to a point, it kind of almost going backward in time. If we could make each farm healthier, more sustainable, we could bring more families back to the community. Participant 6

There is hope that soil health can help farms be more economically profitable, support more family farms, and repopulate the rural agrarian landscape. However, participant 1 did not see hope: "So how is it going to affect our communities? Not quickly. It is gonna be a continuing erosion of the communities as all I can see." The farmer saw that the community's strength and vitality had already dissolved beyond the capacity to repair.

3.3.3. Stewardship, nurture, and care

Farmers have a reciprocal relationship with their soil. Stewardship drives farmers'care for the soil, and as a result, soil provides the farmer with natural capital. Participant 5 said, "I think that there's just some people that love land and being stewards of the land." Farmers feel that their relationship with the soil is two-directional. That both the farmer and the soil serve and take care of one another.

> I don't really own this land. I am here as a steward to serve it. It is a relationship. It [soil] will serve if I serve it well, it will serve me… It is two way. It is a giving on both sides. It's giving and accepting. Participant 3

Other than stewardship, some participants expressed they had a caring relationship with the soil that they compared to the relationship they have with their children.

> It is mostly suppressed, the feminine aspects... I just do truly believe that we're seeing the quintessential symbol of that imbalances, is the kind of the old white male culture. It is emblematic of that 50s and 60s and 70s…It is about domination and control…I've always felt like you know as a female, I am connected. I am connected in a way because my mother is a part of me. I am a part of my daughters. My mother's part of my grandmother. So there's this line, you know, in connection. And a beingness. Whereas, if you're a male, you're a part of your mother, but there's not that physical giving birth. Males are physically and biologically isolated. They have physically 'I came from this being', but they don't give birth. So there's not that unbroken connection of 'I came, I was born from this being I give birth to this'. And that's the piece that I think is missing. It's that deep, deep understanding of connection, and it is not revered, and it is really not respected. Participant 3

Soil degradation is seen as linked to a mindset of dominance over the soil. In contrast, soil health is perceived as the balance between production and nurturing of soil.

Soil health provided an outlook for the farmers to increase their connectedness to nature, as well as a sense of belonging. Soil health gave farmers a reason to congregate and form a peer group to learn with. The farmers perceived that hopefully, by increasing soil health, they could also improve the well-being of their rural communities. They perceived that soil health would give their rural communities additional opportunities that would hopefully foster the reversal of farmers leaving the area by demonstrating viability in farming once again, resulting in increased retention of the next generation of farmers, increased viability for future generations to live in rural areas, and improving rural community economics and food systems.

3.4. Self-determination

Farmers perceived soil health as a means to gain control over their livelihood as they lost their sense of control by being locked into an explorative agronomic and food system. They perceived that by adopting the concept of soil health and accompanying practices, they would be able to gain control of their livelihoods by working in balance with mother nature, which enables them to increase the viability of their farms and improve their physical and mental health.

3.4.1. Gaining control by working with nature

Farmers feel trapped by the food system of which they are an essential foundation. The food system demands they produce more food despite extensive externalities, such as soil degradation and loss of profit in farming. Participant 4 said, "We've tried to raise more, more bushels, more produce, more pounds quicker, faster, and easier. Throw this at it. It'll be better. Well, that is not ending out to be the true story." Farmers felt like they did not know how they were being controlled because of the lack of flexibility and freedom of available agricultural inputs.

> There are certain herbicides that are just like meth. You get on it, you get used to live in this certain way of life and treating your weeds a certain way. And you get trapped in that system… It is hard to break out of that system. … Throwing all of these chemicals out there is not. Not good from a human health perspective and not good for the environment. So I asked our guys a couple of years ago if in their seed treatments if they had insecticides on them. And they all said yes. And I asked them why? And they said, Well, that's how it comes from the seed dealer. Participant 5

Soil health means to them that they are able to gain control over their farming operation and their livelihood by working with nature and by facilitating nature's natural processes. Participant 3 said, "You're working with nature. You're not trying to, you know, overcome it or fight it or do battle or be in a war, so just feels better."

Working with nature would free the farmers from being reliant on synthetic inputs. "It would be wonderful if we just had no synthetic, no need for synthetic fertilizer use. No need for herbicide. Yeah, that would be my perfect. Yeah, yes. Then that takes care of itself," said Participant 6. And that would allow them to gain control over not just how they produce but also the quality of the products they produce.

> That opportunity to really take a little control over what kind of products come off of their farm—the food quality. I think we're much more focused on building a much more nutrient-dense product… We can impact the real quality of the food that we produce by regenerating our soil. Participant 9

Soil health is the piece that empowers farmers to restore the broken food system and return it into synergy with nature.

3.4.2. Freedom, autonomy, and flexibility

Achieving soil health and adopting new agronomic practices that promote soil health gives farmers a sense of freedom, autonomy, and flexibility from the conventional agronomic system that led to their limited profitability and the degradation of resources to which they are bound. Participant 3 said, "It's been liberating to farm this way. It's been very liberating."

> That freedom from [synthetic input applications], we can change our workflow, spread the workload, potentially based on timing of our crops. If you have a cover crop, maybe you don't need to go out and spray. You don't need to be there. That is taken care of for you. So certainly from a labor standpoint. Freedom from outside inputs would be great…there would be an economic benefit and then the time savings, so more family time, less time tied to the farm, greater flexibility. Participant 6

Farmers perceived soil health liberated them from the restrictive dominant food system to which they are accustomed. Soil health provides them the sovereignty and autonomy to choose how they want to produce their crops. It means they are no longer as reliant on deliveries of agricultural inputs or tractor repairmen.

3.4.3. Farm viability

Viability to be a farmer, viability to make a livelihood, and viability to be able to pass this lifestyle on to the next generation of farmers is the hope that farmers see in soil health, and the potential soil health has to bring to agriculture. Soil health is the hope of bringing back ownership of the land to farmers, improving their product quality, becoming adaptable to climate change, and creating sustainability. "I think that the people in our bio-farming group, or at least some of them, have the hope for them is that that they get back to owning their farms," said participant 9.

Even if progress towards healthy soils is slow, the hope for future viability is enough to pursue soil health.

> I don't know if we will see the huge difference. But generations to come that there is soil there. That can produce healthy food as well as keeping all wildlife strong. Participant 10

There is hope and pride that there is farm viability security in the future, and that is essential for driving farmer motivation.

> It is great pride. It makes you feel good, and it's like, you know, a breath of fresh air. I mean, it's exciting. There's potential out there now… It's like a big weight has been partially lifted off of our shoulders. Participant 4

Farmers perceived soil health as an integral and foundational part of securing the viability of their farms by liberating them from a restrictive, dominant food system.

3.4.4. Physical and mental health

Farmers see a threat to their own and their families' physical health due to the reliance on synthetic fertilizers by conventional agriculture.

> It was probably the seed treatments and in the fungicides and the herbicides and the witch's brew that you basically mix. You put those in a tank mix. You don't know how they interact with themselves and each other and with you. The way we farm is not healthy. It is compromising people's health, physical well-being, because [Husband] either he had such a load that his brain just cannot clean itself… They think people with Parkinson's and Alzheimer's literally the brain just cannot flush out toxins. A lot of farmers suffer from it… Paraquat that's one of the worst chemicals for you, you know, contributing to Parkinson's. Participant 3

Finally, soil health provides the security that supports emotional well-being and reduces stress in farming by reducing stress related to extreme climate events, financial burden, connectedness to the land, and the functionality of working in a family business.

> If your soil is in good shape. Then you don't wake up in the middle of the night when there's a rainstorm, and you know the ground's frozen, you know that you're gonna have horrendous erosion events...A healthy farmer, as far as just emotional well-being and reducing the stress as far as just physical, you're not having to borrow the money. You're not burning through. You're not spending all this money on inputs and trying to figure out where you're gonna come up with the money next time. You can get yourself out from under the debt trap. Participant 3

In addition, control and reliance on others by increasing soil health would lead to healthier farms, farmers, wildlife, and people.

> Increase time to do other things, less inputs, less having to rely on your tractors, or the equipment you use, less break downs, less stress. I think that our health would be better. People live longer, maybe because they're not so stressed out. I guess there's probably thousands of benefits to it [soil health]. Better wildlife. Wildlife will be healthier. Insects will be healthier. Our water be healthier, people will be. It is that big old circle again. It'll help to hopefully complete that circle a little bit without having so many little breaks in it. Participant 8

Soil health and soil health practices provide a means to create security for farmers that their own health and the health of their future generations are not at risk for the promise of profit that isn't there.

> The most important thing, feeling comfortable to have my baby out in the field with me, crawling on the floor, eating the dirt, and not feeling like, oh my god, there's chemicals in there. But thinking, oh, this is an inoculation. That's totally fine. Yeah, and it's healthy. Soil health equals human health… I mean, soil health to me means I can let my baby crawl in it and eat the dirt. That's what soil health means to me. Participant 7

Soil health provides a means for farmers to protect and promote their physical and mental security.

Farmers emphasized soil health was about mimicking mother nature's natural processes through soil biology for supporting a self-sustaining system that limits or eliminates synthetic inputs for crop production. Farmers expressed they were re-examining how they perceived economics by embracing this autonomy and lack of reliance on input suppliers as essential requirements for having a viable, sustainable farm plan. Additionally, farmers sensed an increase in self-determination by reducing the risk of toxic chemical exposure and emotional stress.

4. Discussion

The dominant agro-innovation efficiency paradigm frames soil health as the solution to environmental degradation and increasing the economic viability of agriculture. However, this remains a simplified perspective. Soil health has value to society and farmers beyond instrumental value in the form of relational values that emerged from farmers' narratives about their motivations and incentives. The soil health research agenda needs to focus on innovations that promote a plurality of values across the food system to address the dynamic, complex challenges facing the food system. These data document relational values derived from soil health by innovator commodity wheat farmers in the iPNW. However, more data and research is needed to understand the plurality of values across the diversity of farmers, regions, agricultural practices, cultures, and societies (Braito et al., 2020).

Farmers are intrinsically motivated by relational values associated with soil health through self-actualization, esteem, connectedness, and self-determination to fulfill their well-being. Relational values of soils expands our knowledge of values previously identified as cultural ecosystem services, such as spiritual meaning, heritage, recreation, community food sovereignty, culturally appropriate food production, and aesthetic provide value from soil health (Brevik and Sauer, 2015; Friedrichsen et al., 2018; Jónsson et al., 2017; Robinson et al., 2012). The new term relational values recognizes the important two-directional flow of benefit derived from the soil and the soil steward through soil management (Tironi et al., 2020).

In particular, these perceived relational values may play large roles in farmer decision-making when it comes to changing management practices in ways that enhance soil health. Farmers perceive soil health provides them:

1) a goal to work towards,
2) enjoyment and excitement for what they do,
3) confidence and dignity as important contributors to society,
4) belonging and support through improved social capital,
5) the sense of hope forfor the revitalization of rural communities, and

6) an improved sense of self-determination in the viability of their farm and their own health.

Refocusing soil health research and assessments to acknowledge the role of intrinsic motivation surrounding the adoption of conservation behaviors may facilitate innovation that is more easily adoptable. The following sections discuss how to advance change within the dominant agro-innovation paradigm to include the plurality of soil health values and includes an example of how the plurality of values can be incorporated into soil health assessments to support a sustainable food system.

4.1. Adding relational values to the soil science paradigm

To actualize a sustainable food system requires breaking out of the current soil science paradigm that exclusively focuses on the instrumental values of soil (Vanloqueren and Baret, 2009). Widening the breadths of possible outcomes of soil health to include solutions that address the multiple negative social outcomes that agriculture has on human well-being (Stefanovic et al., 2020). To do this, farmers and indigenous stewards need to be recognized as scientists who systematical create and transmit knowledge (Peña, 2017).

Integrating the diversity of intrinsic motivation and relational values of soil health may shed light on how to foster human well-being associated with agriculture. For example, how will this soil health practice support community food sovereignty? Leverage points for causing a shift in the soil science paradigm include (1) capital support for the fostering of niche innovations of radical solutions, (2) increasing diversity and supporting inclusiveness of who and what fields can collaborate and conduct soil science research, (3) increasing support within professional societies and research institutions for inclusiveness and interdisciplinarity, (4) supporting an education system around soil science to include multiple, diverse knowledge systems, (5) increasing professional awards for transformative and interdisciplinary soil science research, and (6) implementing widespread fair forecasting of future impacts of innovations on multiple societal indicators as part of the research process (Vanloqueren and Baret, 2009).

Identification and recognition of soil's plurality values will help effectively govern soil to provide the diverse public goods it provides (Juerges and Hansjürgens, 2018). Effective, efficient soil governance to promote and protect soil security cannot occur if the social benefits and values of soil are unknown and incomplete (Helming et al., 2018). Additional research needs to be conducted to understand the diversity of values, cultural ecosystem services, and intrinsic motivations that farmers have globally, contributing to their choice of livelihood in farming and pro-environmental behavior.

4.2. Soil health assessments

More specifically, in this section, it is discussed how an example of what the shift in the soil science paradigm might look like if a plurality of values were recognized and integrated. Currently, soil health assessments are designed to help mostly privileged commodity farmers and land managers understand the impact their decisions have on soil function and the instrumental values soils provide for mostly privileged communities. However, soil health has additional values and social outcomes that need to be accounted for within land management decisions—relational values. Exclusively evaluating soil health by a list of predetermined biological, chemical and physical properties obscures that the term is valued and associated with valued behaviors. And therefore, the plurality of values soil health holds should be integrated within the conceptualization of the term and its assessment.

Including these additional values into more diverse versions of soil health assessments may increase their effectiveness as decision support tools and motivate the adoption of diverse soil health practices. For example, identifying baseline datasets from land stewarded from multiple cultural perspectives. Support and change are needed from the governmental regimes to adjust conservation policy to account for a plurality of values, but so far, this has had limited success in the United States. For example, currently, there is limited support in the United States within cost-share programs to financially support indigenous soil and water conservation techniques (Peña, 2017) or culturally appropriate soil management to support diverse foodways, such as inter-cropping (Minkoff-Zern, 2019). More research is needed on how to effectively and culturally appropriately integrate the plurality of values soil health has across individuals, communities, contexts, and cultures.

These data provide insight into developing more effective soil health assessments that are goal-oriented, create attainable benchmarks to indicate observable and measurable progression toward meeting the farmer's goal, and are more holistic (e.g., supports farm diversification). Soil health assessments need to go beyond the paradigm that soil health can be assessed with a soil sample removed from its context, culture, farming system, soil stewards, and ecosystem and shift toward evaluating soil within the larger cultural context of which it is a piece.

5. Conclusion

This research study provides data on the connection between soil health and human well-being. Some intrinsic motivators for innovator farmers in the iPNW to adopt soil health induce self-actualization, esteem, connectedness, and self-determination. These themes provide important insight into the relational values that contribute to the farmers' well-being that have been neglected in the current dominant paradigm, which emphasizes soil's instrumental valuation. A qualitative methodology provided a way to collect data from various stakeholders in a manner for understanding a larger breadth of how they value soil. Improved valuation of all assigned values that soil provides society can help lead the way to create a sustainable food system. However, to do so requires a transformation of the current soil science paradigm to include the plurality of values of soil health. A change in the soil science paradigm will require an institutional and social change to support radical innovations. Reflecting on underlying values that have shaped the soil health dialogue and widening soil health innovations outcomes to include relational values as desired outcomes is necessary for transformation. Soil health assessments need to take into consideration the potential larger holistic plurality of values soil health and its outcomes on human well-being, which may help facilitate the transformation of the food system to be equitable, just, healthy, and sustainable.

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Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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