Human-managed soils and soil-managed humans: An interactive account of perspectival realism for soil management

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Abstract: What is philosophically interesting about how soil is managed and categorized? This paper begins by investigating how different soil ontologies develop and change as they are used within different social communities. Analyzing empirical evidence from soil science, ethnopedology, sociology, and agricultural extension reveals that efforts to categorize soil are not limited to current scientific soil classifications but also include those based in social ontologies of soil. I examine three of these soil social ontologies: (1) local and Indigenous classifications farmers and farming communities use to conceptualize their relationships with soil in their fields; (2) categorizations ascribed to farmers in virtue of their agricultural goals and economic priorities relied upon in sociological research; and (3) federal agency classifications of land capability employed by agricultural scientists. Studying the interplay of these social ontologies shows how assessing soil properties and capabilities are the result of previous agricultural strategies informed by culture, agroecological history, weather, soil biodiversity, crop rotation, and the goals held by decision-makers. The paper then identifies the soil relationships and interactions that constitute ontology-making activities. Building on recent work, I outline a novel interactive account of perspectival realism grounded in agricultural

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extension research and ethnopedological data that captures the haptic nature of farmers' soil strategies. This interactive account explains how ontologies are chosen, why they are chosen, and how they interact and inform soil management decision-making. The paper concludes by examining the values laden in these ontologies and those which are causally implicated in the choice of soil management strategies.

Keywords: value-laden ontologies, perspectivism, soil health, land capability classification, soil ontologies, ethnopedology, epistemology of agriculture, agricultural categories

1. INTRODUCTION

What is philosophically interesting about how soil is managed and categorized? The argument of this paper is that whatever soil is thought to be is informed by historical, cultural, and technological interactions which reciprocally shape both soil and humans over generations. These interactions determine how soil is or should be classified and informs decisions about its management. As such, soil categorizations are not limited to current scientific soil classifications but include at least three interacting kinds of social ontologies. These interacting social ontologies include (1) regional, local, and Indigenous classifications different farmers and farming communities use to conceptualize their relationships with soil in their fields; (2) federal agency classifications of land capability employed by agricultural scientists; and (3) the categorizations ascribed to farmers in virtue of their agricultural goals and economic priorities that are employed in sociological research.

Which of these social ontologies is used within a particular context is often determined according to particular cultural practices, agroecological planning goals, or sociological research interests. Rather than conceiving of these social ontologies as isolated, the aim of this paper is to examine their interplay.

To do this, the first section introduces the reader to farmer-focused soil ontologies whilst also explaining why classifying farmers' soil management strategies is a valuable endeavor. It then turns to a discussion of the social ontologies used within agricultural and sociological research. Through a series of case studies, it analyses how the ontologies farmers use, and those that agricultural researchers use, arise out of agricultural research and agricultural practices farmers employ. It traces the processes by which soil social ontologies are formed, how these ontologies lead to further interactions with soil which then reshape and revise these ontologies in light of these soil relationships and interactions. The second half of the paper identifies what it is about these soil relationships and interactions that constitute ontologizing, or ontology-making, activities. An outline for what I call an "interactive account of perspectivism" follows. I conclude, showing how this interactive account explains how ontologies are chosen, why they are chosen, and how they interact and inform soil management decision-making in different value-laden situations.

2. FARMERS' SOIL MANAGEMENT STRATEGIES AND THE ONTOLOGICAL CATEGORIES USED TO ASSESS THEM

How do the ontologies that are employed in farm management decision-making arise? In this section, I begin by explaining why soil management is important globally and locally before briefly discussing how the differences in soil types and local agroecological environments impact farmers' planting choices. By examining research on farmers' decisions in Northern Ethiopia and the Midwest United States, I investigate how the ontological categories that farmers rely upon emerge from social and agroecological interactions with the soil.

Why is soil management important? Farming relies on good soil for plants to grow and is an essential part of the food system. But soil erosion, reduced organic matter content, declining biodiversity, degraded organism habitat, salinization, alkalinization, and chemical contamination make growing food, fiber, and fuel difficult for farmers and impact both local and global food systems (FAO 2017; 2023; USDA 2023).

Finding strategies for sustainable farming that support soils is a concern of worldwide importance. The United Nations declared 2015 the International Year of Soils and in 2017, the Food and Agriculture Organization (FAO) drafted the Voluntary Guidelines for Sustainable Soil Management (VGSSM) in response to the global need. What exactly is sustainable soil management? According to the FAO and, in particular, the World Soil Charter which drafted the VGSSM:

> Soil management is sustainable if the supporting, provisioning, regulating, and cultural services provided by soil are maintained or enhanced without significantly impairing either the soil functions that enable those services or biodiversity. The balance between the supporting and provisioning services for plant production and the

> regulating services the soil provides for water quality and availability and for atmospheric greenhouse gas composition is a particular concern (FAO 2017, 3).

The World Soil Charter definition, which remains in use (FAO 2023), provides an intentionally open-textured language that requires interpretation to be applied. This is because soil isn't the same everywhere and neither are farms and farmers. Soils vary in their texture, chemical, and organic composition as well as in their moisture content, conduciveness as a habitat for soil micro- and macro-organisms, porosity, aeration, parent material (the geologic material from which the soil formed), temperature, and the amount of vegetative cover on the soil surface. In soil science, there are twelve orders of soils that are used to classify soils according to their common properties (e.g. Alfisols, Gelisols, Vertisols) which are each subdivided into suborders, great groups, subgroups, families, and series (FAO 2023). Ethnopedological soil name types, as well as commonly and locally used names for soils, are widespread (Tegene, 1998; Barrera-Bassols and Zinck, 2003; Nyssen et al., 2008; Ludwig, 2016). Farmers' soil management strategies vary not only in response to soil type but also to environmental and cultural factors that inform their decisions and in turn reshape the agroecological environment within which they farm. The ways in which different qualities and relationships with soil interact in farmers' management decisions has been the focus of ongoing research. A series of recent studies in the Tigray Highlands, Dogu'a Tembien district, in Northern Ethiopia show that:

> soil colour, texture and workability are important criteria for farmers, [reflected] in the local soil classification systems, and aid choice of soil fertility strategies [...] *Walka* (Vertisol, Vertic Cambisol): black heavy clay that cracks in the dry season but is waterlogging in the rainy season. *Baekhel:* light soils that were light coloured on limestone (Calcaric Regosol and Cambisol, Luvisol on silicified limestone), *Andel:* dark brown coloured loamy textured soil (Cumulicalcaric Regosol) (Nyssen et al. 2008, 267-8).

Smallholder farmers in Dogu'a Tembien relied on "the interaction between environmental and social factors" in combining knowledge of local soil types, and historically informed crop rotation methods to inform their land use decisions. For instance, deciding whether to use the soils in rain-fed crop production, to leave fallow or irrigate, as well as determining crop rotations: wheat, barley or hanfets, then horse beans; teff, grass pea, wheat, then barley or hanfets; or wheat, barley or hanfets, lentils, grass peas, then left fallow, or if there are early rains then planting maize or sorghum (Nyssen et al 2008, 261).

Research on farmers' management decisions in the Midwest of the United States show irrigation, drainage, and access to either too much or too little water is a substantial factor influencing soil management decisions (Morton et al., 2017).[1] If a farmer suffers a drought, they often decide to adopt sloping land management while farmers whose soil is waterlogged tend to manage their soil by implementing grass waterways and clearing drainage ditches (Morton et al. 2017, 27). Midwest farmers adopt different crop rotations, including corn—soybean; corn—winter wheat or red clover (cover crop)—soybeans in response to weather conditions. Other influences include soil types like the clayey *Gumbo* (Solonetzic) or *Kickapoo* (Udifluvents), soil moisture level, and whether they choose to use cover crops (Wang et al. 2020, 3-5). Crop rotation is also implemented as a weed management strategy. In the Midwest, farmers often rely on herbicides, but when weeds, like *pigweed* (Palmer Amaranth) survive treatments, farmers seek a combination of solutions to cope with the herbicidal (e.g., Glyphosate) resistant weeds (Burgos et al. 2006, 3). In addition to crop rotation, farmers also rotate their herbicides so that they use herbicides with different modes of action in different years to manage crops (Burgos et al. 2006, 3-4).[2]

Knowing what soil types exist in a field provides knowledge of potential importance to soil management decisions. But because soil management requires knowledge not only of soil type but also of drainage, irrigation, slope, previously planted crops, organic soil biodiversity, crop rotation history, and the history of soil amendments applied to fields (and in what quantities), farmers' local knowledge is central. In a recent study of farmers' approaches to soil stewardship, and responses to weather-related risks and conservation goals, Roesch-McNally and colleagues (Roesch-McNally et al., 2017) interviewed 159 Midwest farmers from nine states about their choice to use till or no-till strategies to improve soil resilience:

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1 The farmers in the study primarily farmed either medium-sales small family farms or large family farms. According to the USDA Economic Research Service, farms are categorized as "medium-sales small family farms" if their gross annual sales are between $150,0002 and $349,999 and "large family farm" if $350,000 to $699,999 (Hoppe and MacDonald, 2013).

2 An herbicide's "mode of action" refers to how the herbicide affects the plant's physiology by interfering with growth. For instance, Glyphosate's mode of action is via EPSP Synthase Inhibitors (Burgos et al. 2006, 2).

> We seem to be having these extremes from one year to the next. Like this year it was way too wet. Last year, it was plenty dry. The year before that, it was cold and wet, initially, and then it got too dry after that. I guess you just need to be flexible. Obviously, you can't do anything about the rain but, [...] you [can not] work your ground to death and [...] leave residue on the ground. No-tilling [farming is] what you're going to [do to] conserve more moisture than if it's wide open and getting baked by the sun (Michigan farmer, quoted in Roesch-McNally et al. 2017, 12).
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> I tried to no-till and some of our soils are just really wet and heavy and they don't warm up in the spring and I've just found that [with] the deep tillage, over the years, you certainly get a yield bump from the tillage because you're loosening the soil. (Missouri farmer, quoted in Roesch-McNally et al. 2017, 13).

The Michigan and Missouri farmers did not agree on what good soil is (undisturbed or wet and loose) or how to manage it (no-till vs deeper tillage). Their responses represent some of the different strategies and considerations used by farmers in the United States' Midwest Corn Belt, all of whom relied on corn-based cropping systems (Roesch-McNally et al. 2017, 14-6).

2.1. Categorizing farmers' perspectives, identities, and decision-making strategies

Analyses of interview data, such as the data presented in the previous section, show that agricultural researchers categorize farmers' soil management strategies as being "conservationist" or "productionist" (more on this below). Researchers classify farmers as belonging to one of these categories in virtue of how farmers' agricultural goals and economic priorities influence their long- and short-term planting and irrigation decisions.

Empirical evidence from soil science (Klingebiel and Montgomery, 1961; Janzen et al., 2021), ethnopedology (Tegene, 1998; Nyssen et al., 2008), philosophy (Puig De La Bellacasa, 2015), sociology (Morton et al., 2017), and agricultural extension research (Roesch-McNally et al., 2017) reveal that gaining an understanding of what makes good soil and soil management requires attending to soils' biological and physical attributes, the ecology of farms, the cultures of farmers (and their communities), as well as the categories that are employed within these efforts.[3]

3 The FAO has itself published numerous bulletins and practical resource tools for farmers and extension workers related to specific countries in terms of their soil nutrient profiles

As the descriptions of farmers' soil management strategies above show, weather, season, soil type, soil organic biodiversity, crop rotation, ecological history of the land and community, local knowledge, and culture are just some factors that contribute to farmers' perspectives. Categorizing farmers' perspectives allows researchers to analyze different ways that farmers make decisions about soil and how these influence their management strategies. One might ask, "Why is ontological category-making important?" A response might be that categorization is part of the experimental methods employed in analyzing data. Nevertheless, one might still press, "Ok, so why might *studying* these ontological categories be important?" Studying categories in agriculture is important because the choice of categories shapes what is known as well as how it is known—that is, it shapes the epistemological and methodological results that are arrived at utilizing those ontological categories.

Research attending to the ecological and cultural aspects of soil management often entails the positing or constructing of social ontologies, identities, and perspectives. Different ontological categories are used to frame the way in which ecological and cultural relationships are evaluated. Grounded theory approaches, where data are collected and analyzed—and from this, a theory or ontology is generated—are common in agricultural research. For instance, the earlier mentioned interdisciplinary study by Roesch-McNally and colleagues first conducted in-depth interviews with farmers in the Corn Belt to identify how farmers discuss their approaches to soil and sustainability in response to extreme weather conditions. The researchers concluded on the basis of their analyses, that the ways in which farmers conceptualize their agricultural goals, values, and priorities is according to a "soil stewardship ethic" (Roesch-McNally et al. 2017, 3). The soil stewardship ethic forms a perspectival stance that shapes farmers' management decisions. Such a stance includes approaches to weather-related risks, social relationships in their community (including observing neighboring farmers' practices), and the weighing of short-term goals (like high seasonal yields) and long-term goals (like saving and building up soil for future generations) (Roesch-McNally et al. 2017, 4-5). In a separate study, sociologists Morton and colleagues (Morton et al., 2017), relying on data from a 2012 survey of 4778 Midwest farmers, analyzed the adaptive management strategies that farmers chose in response to soil degradation. The researchers identified where farmers had expressed control over the biophysical situation of their farmland and where farmers' expressed beliefs and values

(FAO 2022), literature directed to the needs of smallholder farmers and local agri-food systems (FAO 2021), as well as studies devoted to intersectional issues of agriculture, gender, and sustainable soil management (FAO 2019).

in their perception of their identity as “a good farmer” (Morton et al. 2017, 24). Analyzing the survey data, they posited two categories of farmer identities that had the potential to influence their choice of management strategy: “conservationist” and “productivist”; where conservationist farmers valued long-term goals of soil resilience as well as promoting productive land, and where productivist farmers prioritized seasonal short-term management and focused on high yields (Morton et al. 2017, 25).

In constructing these categories, both teams of researchers relied on earlier work that analyzed farmers’ social communities. Some of this work (e.g. Rogers 1995) highlighted the important role played by farmers sharing knowledge based on their observations of how new technologies worked, or did not work, on neighbours’ adjacent fields. Farmers thus reflected on how technologies might work on their fields by comparing the soil, field size, crop, irrigation system, treatments, and practices to those currently used before considering whether to adopt or not adopt new technologies. Whereas Roesch-McNally and colleagues’ categorization of farmer’s decision-making perspectives in terms of a “soil stewardship ethics” emphasized the reflective and social character of farmer-evaluated risks and strategies (including both short-term and long-term planning), Morton and colleagues’ “conservationist” and “productivist” categorizations of farmer identities emphasized a more static account of farmers decision-making perspectives. Identities are “activated” in management decisions, revealing their values and beliefs (Morton et al. 2017, 19; *cf.* Verplanken and Holland 2002).

2.2. Rethinking categorizations of land capability and ontologies of soil management strategies

Are ontologies fixed? Do they develop, and if so, how do they develop and change? In this section, I examine how an historical ontology of soil management, devised by a U.S. federal agency, was reinterpreted through the expert knowledge of culturally and agroecologically informed management practices used by communities in the Ethiopian Highlands. The case study illustrates how soil ontological categories interact with community-based expert knowledge to inform normative assessments of good farming practices.

Categorization of soil management relies on other categorizations made by previous researchers. One of these, widely cited in research on soil management worldwide, is the United States Department of Agriculture (USDA) “Land-Capability Classification” (Klingebiel and Montgomery, 1961). This aimed to provide a classification of soil by grouping soil into categories based on their use and management, as they call them: "capability units, subclasses and classes." It was not intended as a static system of classification but as one that required interpretations that allowed for it to make sense to the user. Information concerning the kinds of soil present in the field, what the farmer intends to do with them, and which crop varieties are either anticipated or have been planted, is required to make sense of the classification (Klingebiel and Montgomery, 1961). Not intended for use outside the U.S., it only specified capability categories that reflected U.S.-based environmental conditions and management practices. For instance, it categorized Class III soils as those with

> severe limitations that reduce the choice of plants or require special conservation practices, or both [...] limitations of class III soils restrict the amount of cultivation: timing of planting, tillage [...] resulting from (1) moderately steep slopes; (2) high susceptibility to water or wind erosion," and Class IV soils as those with "very severe limitations [...] requir[ing] very careful management [and limited] as a result of (1) steep slopes, (2) severe susceptibility to water or wind erosion, (3) severe effects of past erosion (Klingebiel and Montgomery 1961, 8).

Despite the US-focus, the 1961 Land-Capability Classification has been modified to fit different agricultural regions both within and outside the U.S. by taking into consideration local environment and local farming practices, and the ecological-cultural histories of generations of farmers' management strategies. For example, in developing a conservation planning framework for the Northern Ethiopian Highlands (Belay Tegene, 2003), the Land-Capability Classification is first modified and then combined with GIS and local cultural conservation technologies. Soil loss from tillage is significantly different in the Northern Ethiopian Highlands than in the U.S. as it is impacted by several intersecting factors: soil eroded by runoff, tillage by ox-drawn plough (causing downward transfer of large masses of soil), as well as the history of local indigenous soil management strategies to manage erosion. Importantly, soil conservation plans that do not take into consideration both ox-drawn tillage erosion and the history of indigenous soil management techniques, are not applicable to land use in the Highlands (Belay Tegene 2003, 24). Including the biophysical and cultural conditions within a land capability classification meant inclusion of specific effects and causes of erosion and indigenous soil practices. A modified "treatment-oriented" land capability classification was then mooted before being further evaluated and modified (Belay Tegene 2003, 25).

> The treatment-oriented classification recommends that the cultivable cropland categories be treated with broad- or narrow-based terraces, bench terraces, hexagons, mini-convertible terraces and hillside ditching. However, the history of conservation in Ethiopia clearly indicates that imported technologies, such as those mentioned above, have, in most cases, failed to win the acceptance of farmers. These non-indigenous soil conservation technologies failed [... because of] their demand for a huge labour force for their construction and maintenance, that they put large areas of land out of production, encourage the spread of weeds, provide shelter for rodents, etc. [... and] the treatment-oriented scheme assumes construction of the recommended measures by machines, the realities of the northern Ethiopian highlands dictate that they be carried out by manual labour (Belay Tegene 2003, 29-30)

The treatment-oriented classification is found unsuitable without modification with the inclusion of several indigenous conservation techniques including contour ploughing and the construction of a *weber.* Contour ploughing is practiced on steep terrain which produces furrows within which water collects and slowly filters into the soil, thereby reducing erosion (Belay Tegene 2003, 42-3). A *weber* is a semi-permanent terrace structure which is comprised of a series of discontinuous embankments and terraces (Tegene, 1998). In high terrain regions, *kab* or *kirit* are built with stone walls and embankments to prevent runoff from steeper slopes (Tegene, 1998; Assefa and Bork, 2014).

Building *weber, kab* or *kirit* is a community activity as they require a lot of manual labor. Groups of five to fifteen people make up a *debo* which is the social group of neighbors and relatives,

> the owner [of the *terrace*] is expected to collect stones and put them at different places of the farm field [prior to] construction [...] the owner also prepares food and drinks to serve the [*debo*]. Before the group starts to construct the terrace, some ritual activities are conducted to ensure the longevity of the terrace (Assefa and Bork 2014, 937).

The agricultural and cultural history of indigenous soil management also shapes the normative categories of what is a "good farmer." In surveys and interviews with farmers and elders, a good farmer is one that takes care of the terraces, "a person who does not maintain or construct terraces on his farmland is considered a lazy farmer [... and] the community may fine or cast out the person from social interaction" (Assefa and Bork 2014, 940).

The cultural practice of building *weber, kab* and *kirit* for soil management and the structuring of communities and values has a long history in the Ethiopian Highlands. Separate research conducted in Chencha-Dorze Belle, relying on both household surveys and interviews with elders, attests to the cultural history of stone-walled terraces (Assefa and Bork, 2014). Oral histories shared from elders in Chencha-Dorze Belle as well as other parts of Chencha indicate that the terraces were "as old as the agricultural activities in [Chencha-Dorze Belle] and their ancestors were the ones who designed and constructed the terraces [...] the cultural landscape passed from one generation to another" (Assefa and Bork 2014, 937). In addition to the oral histories shared by the elders, field data from archaeological research has supplemented research on the cultural history of indigenous soil conservation practices. *Kab* and *kirit* are often constructed with terrace walls that are filled using local materials, for example, with stones and wood charcoal (Assefa and Bork 2014, 935). Recent archaeological research uncovered several pieces of charcoal in the remains of terrace walls. Accelerator Mass Spectrometry (AMS) dating of charcoal located 30 centimeters below the soil surface suggested a radiocarbon age of 795 +/- 30 BP (Laboratory No. KIA41856), aged at 1186-1202 and 1206-1277 (Assefa and Bork 2014, 936).

Overall, it is particularly striking to note the different categorizations of farmers and farmer soil management practices that are made. The above has recorded at least five: the FAO Voluntary Guidelines for Sustainable Soil Management, the USDA Land-Capability Classification, soil scientists' construction of the "soil stewardship ethic," social scientists' categorization of farmer identities into "conservationist" and "productivist"; and a single case study representative of a much larger body of farmer-centered and self-identified categorizations of farmers' cultural identity and soil management practices.[4] In the farmer- and culture-focused categorizations, the history of culturally based soil management practices, as well as the historically made and remade agroecologies within which farmers maintained their agricultural practices, was centered in the categorizations of soil management strategies, land capability classifications, and normative categories of what it means to be a good farmer. Cultural practices and a farmer-centered approach to soil

4 Farmer identity has been captured in the survey data in several ways that have included both socioeconomic group, culture, and self-identification as a "good farmer," but also in terms of farmers' identifying through their belonging to a category of farmer, e.g., their identity as a dairy farmer, "I am a dairy farmer and always will be ... [dairy farming] is a way of life, our way of life" (Warren et al. 2016 2016, 9). Identity has also been linked how farmers view themselves in light of what they think is the purpose of their farming, e.g., "food production [is] the moral purpose of farming" (Raman et al., 2015 2015, 57).

and land capability have social, ecological, and agricultural impacts insofar as they redefine what is capable land, agriculturally productive soil, good soil management practices, well-maintained farms, and good farmers.

One example of this farmer-focused categorization/recategorization process of land, soil, practice, farm, and farmers is in the revised soil capability classifications that can be found in Assefa and Bork's (2014) and Belay Tegene's (2003), which effectively recategorized Class III and IV soils in the original US-based "Land-Capability Classification" of Klingebiel and Montgomery (1961). Originally categorized as soils that were defined as having either severe or very severe limitations due to their steep slopes (Klingebiel and Montgomery 1961, 8), Class III and IV soils were recategorized as soil that is more fit for agricultural purposes when evaluated for its agricultural capacity in the Ethiopian Highlands given its unique ecological-cultural history of indigenous soil management practices that made the soil agriculturally suitable through the histories of terrace-building. What was also revealed in the process of this recategorization was how attendant farmer and community-led categorizations relied upon categorizing farms in terms of well-maintained terraces and good farmers as those who built and maintained terraces within their communities as part of their culturally and ecologically based soil management strategies.

Studying both how soil conservation methods are evaluated, as well as the ontological categorizations that are employed in studying the management strategies of farmers in different agricultural communities, provides the means by which the different suites of ecologically and socially embedded values and practices interact and shape farmers' choices. Doing so directs attention to the ways different categorizations shape how farmers' interactions with the soil are characterized in the study of them. Analyzing the ontological perspectives and categorizations employed provides the means by which they can be judged to be apt for the purposes employed, and whether they reflect the relationships, practices, and interactions that exist. In doing so, it also provides the opportunity to reconfigure the social and ecological categories employed in multiple ways and for multiple communities. Critically revising the institutionally designed USDA soil capability ontologies, farming communities in the Northern Ethiopian Highlands provided soil capability ontologies that were informed by their own expert knowledge of generations of soil care. This community informed reconfiguring of soil ontological categories also has significant epistemological and social implications for agricultural scientists as well. The community-led reconfiguring of practice-based soil capability ontologies has the potential to change the ways in which soil management and soil crises are framed and studied within the agricultural sciences, by correcting problematic categorizations and the value assumptions that underpin them.

Soil degradation is frequently discussed as being the result of poor management, a problem that needs urgent fixing (FAO 2013). In “Making time for soil: Technoscientific futurity pace of care,” Puig de la Bellacasa argues that treating soil management as a “temporal emergency” of soil degradation relies on “productionist” framings of soil management that are problematically reductive (Puig de la Bellacasa 2015, 692-3). Describing how soil care is treated as a temporal emergency, she writes:

> The future of soils appears pulled forward by an accelerated timeline towards a gloomy environmental future, while the present time left for action is compressed by urgency [...] consistent with a hegemony of future oriented timelines [...] of technoscientific futurity that associates the future with progress, with an ethico-political imperative to ‘advance’ that remains solidly ‘progressivist’ timelines—while the past acts as a discriminatory signifier of developmental delay (Puig de la Bellacasa 2015, 694).

The idea Puig de la Bellacasa captures here is that technoscience and new strategies will be what saves soil, not past practices. The technoscientific futurity of soil degradation both categorizes the problem and preemptively prescribes the only solution whilst simultaneously devaluing historical and cultural practices. The problematic nature of the technoscientific futurity ontology has been described as one where anticipation of the technology fix is one of permanent anxiety where what we have in the present is “contingent on an ever-changing astral future that may or may not be known for certain but must be acted on nonetheless” (Adams et al. 2009, 247). The problem with productionist and technoscientific futurity ontologies is that they treat soil management as control over soil rather than care of it (Puig de la Bellacasa 2015, 701). Applying a feminist philosophy of care to soil, Puig de la Bellacasa provides an alternative ontology. Soil management is recategorized as “care work” to draw attention to practices depreciated as unscientific by productionist ontologies: “soil labors [entail] everyday mundane maintenance, repetitive work, [and] require regularity and task reiteration [... the] work of care takes time and involves adjusting to the temporal exigencies of the cared-for” (Puig de la Bellacasa 2015, 708).

3. HOW DO ONTOLOGIES DIRECT PARTICULAR ACTIVITIES AND ARE ALSO DIRECTED BY THEM?

What the farmer, agricultural researcher, institutional, and Indigenous soil ontologies discussed in the first half of this paper have in common is that they all arise out of interactions between soils, humans and their management of soils, and the multiple ontologies they employ. These are practice-based ontologies: ontologies that are developed and changed through the activities of those using them. The categorizations discussed so far have had a particular characteristic common to all of them. They involve the categorization of ontological perspectives on soil management and identities of farmers, often with the explicitly stated goal of understanding the bases for farmer decision-making around soil management, and the assessment of land in terms of its agricultural potential given the application of different soil management strategies. Each carves the world up into different ontological categories that are employed for a purpose. How they do this and what resources they rely upon to ground these categorizations matters. Farmers' own ontological categorizations may be felt and expressed by farmers in ways that coincide, partially coincide with, or differ from those circumscribed by soil science, social science, governmental or non-governmental research. Examining practices and processes that contribute to the making of these ontological categorizations provides the opportunity to reconsider these ontologies and reframe them, as the above discussion of the work of Belay Tegene, Assefa and Bork, and Puig de la Bellacasa has shown. This is important as ontological categorizations shape how concepts relating to soil can and should be understood.

One concept impacted by soil management categorizations is *soil health.* Soil's properties, capabilities, and anticipated future capabilities, have long been described in terms of soil's productivity, capability of maintaining high crop yields, resilience to erosion, possession of high levels of biodiversity in its soil biota, or appropriate levels of nutrients (Lehmann et al., 2020). These capabilities and properties were earlier captured in the concepts of *soil fertility* and *soil quality* (Hopkins, 1910; Letey et al., 2003). Rather than being based on the reproductive capacity-grounded metaphor of soil fertility, soil health is intended to be a more holistic concept that includes the health of soil multispecies soil complexes (e.g., soil exudate microbiome, soil microbial community, soil rhizosphere, soil-crop-farmer relationships), provides specifications of beneficial levels of the chemical components of soil (e.g., level of nitrogen); as well as how soil can be sick (e.g., through toxic acidification, salinity, phosphorus fixation, or other chemical contamination)

(Malley 2017; EPA 2023). Because the soil health metaphor applies to so much, it has also been criticized as not being precisely defined and therefore of less use to farmers and agronomists (Lehmann et al., 2020; Janzen et al., 2021). In their recent paper "The 'soil health' metaphor: illuminating or illusory?" Janzen and colleagues offer a definition of soil health as "the vitality of a soil in sustaining the socio-ecological functions of its enfolding land" (Janzen et al. 2021, 2). They also curiously concede that, "if 'goodness' of soil could be succinctly conveyed in scientific jargon, there would be no need for metaphor" (Janzen et al. 2021, 3).

What appears to have been left out of the discussion is how the *meaning* of soil health is informed by the categorizations of soil management practices, land capability classifications, and categorizations of farmers caring for the soil. Understanding soil in a holistic way is dependent upon understanding it through a particular culture, soil type, management approach, history of farming practices, historical ecologies, and past and anticipated weather events. For instance, take the US Land-Capability Classification. Land in Class II is defined in terms of the need for soil management due to its limitations that may involve one or more of the following: "moderate susceptibility to wind or water erosion or moderate adverse effects of past erosion, wetness correctable by drainage but existing permanently as a moderate limitation, […] slight climatic limitations on soil use and management" (Klingebiel and Montgomery 1961, 7). A land capability classification informs farmers' practices of soil management whether it is the land capability categorizations used within a farming culture or community, shared between two neighboring farmers, or written down or mapped formally. In drought-prone environments, cover-cropping is one practice employed for soil protection from erosion due to wind. For those with land where both drought and waterlogging are possible, adjusting soil moisture levels and better water filtration through the mechanical leveling of fields, the building of and maintenance of ditch or row drainage provides measures that protect soil are practiced. As a farmer from Iowa reports:

> You're trying to think ahead and say, how can I make that soil more resilient or able to handle the stresses [...] whether it's a dry stress or too much rain or something like that, you know? By having that structure and those roots there [from using cover crops] and holding on to that soil and maybe, hold on to more nutrients through [the winter] (Iowa farmer, quoted in Roesch-McNally et al. 2017, 12).

If understood holistically, soil health would indeed, as the Iowa farmer mentions, include the relationship with the roots and the soil and the attendant root-soil complex relationships that make up what soil scientists refer to as the soil *rhizosphere*. The rhizosphere is a concept that captures the unique populations of microorganisms that are influenced by the release of photosynthetically fixed carbon from plant roots and their polysaccharide-rich mucilage. These root exudates serve as "bait" for root pathogens and are capable of sequestering toxic metals such as Al^{3+} (Hawes et al., 2000). Exudates enable plants to request help from rhizospheric microorganisms and are capable of changing their chemical environment in order to gain more nutrients (e.g., the plant will acidify the soil in order to access nutrients in the surrounding soil (McNear, 2013). A holistic understanding of soil health would include local weather and the effects of past seasons. The speculation of the farmer and the community and farming identities as a good steward or good farmer, a stance that they use to inform their anticipation of how the soil in their fields will behave in light of the different soil management activities they choose to use and how their neighbors have fared with their strategies (e.g., overwinter cover cropping) would also be included.

Janzen and colleagues claim that soil health, or at least their definition of it included above, "will always be context-dependent" (Janzen et al. 2021, 2). While context-dependency initially sounds like an appropriate way to include all the cultural, ecological, and historical variables in and around the networks described as soil, the question we might ask is, "*Why* is it context dependent?" I argue the reason is because soil health is something that is known and made through multispecies activities that include farmer goal-oriented practices. That is, soil health is *descriptively* context-dependent, because its *existence* is dependent upon a network of historically embedded cultural and ecological relationships, interactions, and practices.

3.1. An Interactive account of perspectival realism for soil management and soil health

What does it mean for soil health to be known, made, and framed through networks of relationships, interactions, and practices? In the previous section, I showed how ontologies were developed and changed through the interaction of social communities—whether farmers, agricultural researchers, or agricultural institutions—with soil. Asking and attempting to answer how these interactions, in general, lead to the formulation of such ontologies occupies the remainder of the paper. The focus of the present section will be to inquire into the nature of these interactions with and for soil that constitute ontology-making activities. This is an important question to be addressed because the answer to it tells us how concepts, like the notion of soil health introduced in the previous section, can be known.

Research on farmers' soil management practices, and how they describe their interactions with soil, suggests a reconceptualization of soil health. If soil health is to be understood as a concept grounded in farmers' soil management decisions and practices, then it is a concept that is best understood in practice—through the farming cultures and histories of management, farmer identities, land capability classifications, soil types, and soil management strategies. This is, or so I will argue, because soil health is valued, assessed, and actualized through culturally and historically situated farmer-focused goals and plans. Concepts of soil health are shaped by farmers' management strategies in response to ecological features of the local geography and weather and within communities and cultures. Normative assessments like *soil goodness* or the *wholesomeness* of soil are understood from within these overlapping situated perspectives.

As such, I contend soil health may be helpfully understood as being inherently perspectival because it is in virtue of ecologically, geographically, and culturally situated interactive relationships of soil-individual and soil-community that assessments of health are made. "Perspectival," as it is used in philosophy, often includes reference to the partial nature of knowledge as it is viewed from a particular point of view or standpoint. It is from such a point of view that understanding, or seeing the world, can be discussed with regard to the positionality of the subject (Harding 1995, 341). Positionalities, moreover, simultaneously provide the means to understand the world while also limiting this understanding.

In recent philosophy of science, both realists and pragmatists have argued that scientific objects of inquiry and representation (e.g., theories, observations, models, natural kinds) are best understood as perspectival, meaning that these epistemic objects and processes are the sorts of things that can be perceived from different points of view (Chirimuuta, 2016; Massimi, 2022). The notion of a *point of view* often implies that there is a subject who *sees* something or *visualizes* it from their particular standpoint. When referring to the perspectival nature of scientific theories, *seein*g is a frequently used metaphor. Examples borrowed from color vision, are often used to illustrate the partiality of what is seen. The fact that objects aren't colored in any sort of objective sense, but are colored only in terms of how that object is seen or perceived by a particular observer, is an example that is commonly used. There is no definitive color— *the* color—since color is always dependent on one's perceptual configuration; "there is only *the color of the rug as seen by a* *dichromat* and *the color as seen by a trichromat*" (Giere 2006, 33, emphasis added). Recent scholarship in perspectivism pushes back against the use of the vision metaphor. For instance, Chirimuuta (2016, 747-51) argues that vision metaphors are neither the only or even the best way to understand perspectivism and we would do better if we swapped the vision metaphors for haptic ones. What might this shift in metaphors do? And what might shifting to a haptic metaphor afford with regard to our ability to understand or explain something about the world? For Chirimuuta, the choice of a haptic metaphor over a vision metaphor strengthens the perspectivist's claim about interactionism—that scientific knowledge relies on our active engagement with the world rather than something that we passively collect as the world spins by:

> the sense of touch requires physical contact and purposeful exploration on the part of the perceiver, [and] it is obvious that with touch one apprehends an external reality in virtue of and not in spite of its interactive/interested nature. By analogy, perspectivists should investigate the thesis that scientific representations inform us about the natural world in virtue of their interactive and interested qualities (Chirimuuta 2016, 749).

Thinking about the difference in how the perceiver engages with the world using metaphors based on touch rather than vision allows us to consider the active and purposive nature of perceiving in a way that seeing does not. What is touched also includes an intention to understand or at least interact with a reality that is made when interacted with.

Adapting Chirimuuta's suggestion for use in agriculture, I will show how conceiving of farmers' practices using haptic metaphors captures both the interactive nature of soil relationships and the interactions between different soil ontologies and social ontologies. This use is also central to understanding the multiple positionalities of farmers in ways that visual metaphors neglect. Using haptic metaphors for soil management directs attention to the soil-human interactions farmers engage in when managing soils. After discussing these haptic soil-human interactions, I outline what I'll refer to as an *interactive account of perspectival realism* for soil management and soil health. This interactive account of perspectival realism takes realism to be constituted in agricultural practices. It centers farmer's practice-oriented kind-making or *kinding* activities, that include farm management activities like planting decisions such as crop rotation, irrigation and drainage, the making and application of compost, constructing and maintaining terraces, digging and clearing ditches, irrigating or draining fields, and the addition of soil amendments that contribute to the making and remaking of the land and soil in relation to the farmer, ecology, weather, and community.[5]

The haptic nature of soil-human interactions is manifest in the different activities collectively grouped in the category of soil management already mentioned by farmers from both the American Midwest and the Ethiopian Highlands. Midwest farmers' reports described soil as something that they work with, or that is "worked," "fertilized," and "plowed" (Roesch-McNally et al. 2017, 12). Feeling the wetness, dryness, weight, texture, and temperature of the soil, provides information important to decision-making about whether to till or not to till: "some of our soils are just really wet and heavy and they don't warm up," with "deep tillage [...] loosen[s] the soil" (Roesch-McNally et al. 2017, 13). Ethiopian Highland farmers centered descriptions of the activities of building stone walls and embankments in response to soils at risk of running down steeper slopes (Tegene, 1998). The culturally-defined haptic nature of terrace-construction captures the owner's responsibilities to the soil and to the community of "collecting stones," "putting them at different places [on] the farm field" for the *debo,* as well as "prepar[ing] food and drinks to serve the [*debo*]" prior to the start of construction, and conducting "ritual activities [...] to ensure the longevity of the terrace" (Assefa and Bork 2014, 937). The social interactions of terrace building are defined in terms of the constructive and preparatory activities that require "many hands" and "much manual labor." These also shape the normative category of "good farmer" as one that constructs and maintains terraces (Assefa and Bork 2014, 940).

In addition to these culturally and ecologically specific efforts used to evaluate and maintain soil, another set of activities used to assess soil and inform farmers' soil management practices is soil testing. Soil testing is a practice that has a long history. The twelfth century agricultural compendium, Kitāb al-filā-ḥah, ("Book of Agriculture"), collected by Abū Zakariyā Yaḥyā ibn Muḥammad ibn Aḥmad ibn al-'Awwām's, discusses soil assessment and improvement techniques, the production of composts and manures and their application, techniques for leveling land for irrigation; *Qalīb* or soil tillage, digging, ploughing and ameliorations of the soil, and explanations of how legumes benefit soil (Ibn al-'Awwām., 2000; Lord, 1979). *Kitāb al-filā-ḥah*

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5 "*Kinding* activities" here is intended to collectively capture the historically and culturally embedded interactive processes and practices that individuals and communities use together in making, discovering, delimiting, reconstructing, and sharing kinds as well as how these vary within different scientific disciplines (Kendig 2015, 1-6) and within distinct local and indigenous communities (Kendig 2020, 2).

included the agronomical traditions from 112 early agronomists and other sources collected together in the treatise. While the *Kitāb al-filā-ḥah* is a written collection of traditional agricultural knowledge, agronomic practices are also passed down through generations of farmers through teaching and doing.

The teaching of new "farm hands" to evaluate soils by, for instance, handling soil to feel for a clayey residue or a dry sandy texture; picking up a handful of soil to squeeze it to decide whether the soil is dry enough to dig in and plant; or sifting in the soil to evaluate its organic components are some practices shared between farmers (Curell, 2016). One practice commonly used by many farmers worldwide to assess the soils' organic components—or at least some of the more prominent ones—is to collect, sort, and count worms in a particular region of farmland (Curell, 2016). Counting worms is used to inform a farmer of the soils' living communities, and the number of worms is taken to be an indicator of previous worms' contribution to soil organic materials such as worm casts, whether the soil has suitable minerals and moisture levels for worms to thrive in, and whether there is compaction that reduces the number of worms (Curell, 2016). All of these factors can potentially inform farmers' decision-making around future soil and crop management. While the practice of worm counting is ubiquitous, the meaning of the findings is judged on the basis of local knowledge, type of worms, local expectations of soil moisture, and crops planted, all of which refer back to the history of haptically shaped agricultural ecologies by virtue of generations of farmers' planting, tilling, and the sharing of soil management strategies from elders to young farmers in the area.

Understanding local processes of compost-making, which sorts of plants are available and used, as well as the types of worms that cocreate the compost matters. Recent research reveals that "the quality and characteristics of most chemical properties such as CEC, NT, Av. P, K, Zn and the like depends on the types of earth worm species (locally collected or the world wide adapted *Eisenia fetid*) and types of compost (vermicompost or conventional compost)" (Eshetu et al. 2022, 15). Not only does the local species of worm matter, the kind of compost that is used and how it is made are also significant difference makers with regard to what is known by counting worms in relation to soil assessments. For instance, the means by which soil is enriched covaries with farming practices and cultures as these inform how compost is to be made. Compost might be made by combining field pea, fava bean, wheat and barley straw following a recent agricultural extension study at Sinana Agricultural Research Center in the Southeast Highlands of Ethiopia (Eshetu et al. 2022, 15), or by mixing three parts sawdust or wood shavings to one part manure and fresh grass clippings as the combination the Michigan State University Agricultural Extension in the U.S. recommends (Gould et al., 2022).

Haptic soil assessment techniques are often used on their own. But they can also be used by farmers in identifying the samples farmers choose to send off for "precision soil sampling" (Starr and Eck 2021, 26). Precision soil sampling requires farmers to collect samples to send for chemical analysis. Fields are not homogenous with respect to soil type, amount of organic matter, water, or nutrients. This heterogeneity may be the result of several factors including soil type, historic use of the areas for crops (e.g., a cotton-maize-soybeans crop rotation may have been used, or peanuts may have been planted), past yields, whether there were livestock present (e.g., cattle, chickens, swine), or whether drainage or irrigation systems were maintained. How to sample depends on farmers' prior knowledge of the farm and farming practices which also informs the choice of which method a farmer may prefer (Starr and Eck 2021, 26). For instance, precision soil sampling using the "zone" method requires farmers' knowledge, which includes knowledge of past yields for the areas to be sampled, topographical information, agricultural technologies employed, and local ecology (Starr and Eck 2021, 27). In this way, farmers' knowledge informs how sampling units are identified as exemplar samples from different distinct ecological areas (e.g., soil near a higher elevation or ridge, lower field, in a field where soybeans were grown continuously in the years prior, or soil near an irrigation pivot) (Starr and Eck 2021, 27). As such, which soils farmers choose to identify as samples depends on farmers' haptic interactions through farming practices with the different types of soils in different regions of their fields in different growing years. These haptic interactions inform their choice of what they consider exemplar samples given their knowledge of the soil through working with it, thereby providing the grounds for identification of the sampling units.

Focusing on the haptic interactions of farmers with soil provides useful ways of understanding farmers' conceptions of soil health, through their conservation strategies and soil management practices. As the diverse methods of soil conservation and management in the above examples show, cultures and practices make fields and soil what they are as well as how they are evaluated. Through cultures and practices of soil testing and managing, soil health as an agricultural concept is also made and remade through histories of farmer-soil interactions. This is not just abstract conceptual remaking but reflects the actual remaking of soils through farmers' soil management decisions. Farmers' interactions can intentionally or unintentionally make or remake the soil into the kind of soil the farmer seeks to interact with or conserve for future generations.

Taking an interactive approach to perspectivism and a focus on haptic interactions reveals an equally interactive causal understanding of agricultural research on soil management strategies. The soil-human relationship is one that is causally reciprocal in the making and remaking of soil and humans through soil management decisions and practices. That is, human-managed soils and soil-managed humans are reciprocally cause and effect of their own existence, both the result of the history of human-soil agricultural-ecological interactions.

The practice-focused interactive approach to perspectivism outlined here reconceives soil health as a reciprocal notion of soil-human interactions that are embedded within cultural and ecological histories of farm management activities. As a reciprocal notion, it connects soil with those whose care and management contribute to the making of the kind of soil that is the result of these intentional and unintentional interactions. But it also captures the ways in which the soil that results from the history of these interactions in turn shapes the kinds of soil management activities in the future, thereby capturing a reciprocal and multidirectional cultural-ecological causal system.

4. THE VALUE-LADENNESS OF ONTOLOGIES

In this final section, I show how my proposed interactive account of perspectivism is required if what we want to do is to understand how ontologies are chosen, why they are chosen, and how they are used to pursue different goals in different value-laden situations.

How does my practice-focused interactive account of perspectivism help reveal the haptic relationships on which soil concepts and categories are grounded in agriculture? Categories and concepts mark what is of interest or for a particular purpose. They carve the world up into its perceived natural and social kinds. The categories and concepts chosen for a particular agricultural purpose make ontological, epistemological, sociological, and practical differences as they impact what is conceived of as good soil as well as who are good farmers, and what are good soil management practices. How farmers, farms, and their farm management strategies are categorized affects how soil is understood and assessed. An interactive account of perspectivism directs attention to how categories and concepts are made and how they provide the means by which soil goodness can be understood through farmers' culturally and ecologically situated soil management strategies. In doing so it explains the relationship between categories, concepts, choices, and the value-ladenness of these.

"Value-ladenness" is used to identify the role and expression of value in several different ways. For instance, when referring to the value-ladenness of categories and concepts, the ladenness may refer to different kinds of values, e.g., either epistemic values or non-epistemic values. But, if what one is interested in is not just what are the kinds of values that are laden in a particular category or concept, but instead how the *choice* of categorizations or concepts is itself value-laden, more clarification is needed. To help clarify, I refer to Ward's (2021) recent taxonomy of the value-ladenness of choices. Ward identifies four ways in which choices can be value-laden: values can serve as reasons that can motivate someone's choice; justify it; be causally implicated by the choice made; or be impacted by a choice that is made (Ward 2021, 54-5). Elaborating on values laden in theories that are causally implicated by the choice made, Ward clarifies, "when [authors] claim that scientific choices promote values, they mean that those choices facilitate the flourishing of certain goods in the world" (Ward 2021, 57). Discussion of this sort of value-ladenness in the science and values literature in philosophy is not as common as discussion of the other three sorts. She suggests that although pervasive, the relationship between values and choices as causal effectors is often hidden (Ward 2021, 57). Although less common, examples where it has been explicitly discussed exist both within the values in science literature as well as outside of it.

A recent critique on natural kinds argues that the epistemic value of natural kinds cannot be explained independently of the non-epistemic values that underpin them (Kendig and Grey, 2019). The critique is aimed at those seeking to justify epistemology-only accounts of natural kinds arguing that all that is required for natural kinds is that the clusters of properties relied upon for kind-membership is that they are "sufficiently stably co-instantiated to accommodate the inferential and explanatory uses to which particular sciences put [natural kinds]" (Slater 2015, 396). Proponents of epistemology-only accounts contend there is no need to rely on non-epistemic values or metaphysical commitments as all that is of epistemic value is the stability of the clusters of properties that license inferences. Kendig and Grey disagree, arguing that the stability of these clusters can only be explained in terms of non-epistemic values such as metaphysical commitments that provide an answer to *why* these clusters of properties and not others, are those that can license inferences:

> Attributions of stability are always made on the basis of assumptions about which counterfactual perturbations are relevant. Those assumptions include certain underlying metaphysical commitments. The epis-

> temic value of a natural kind is thus contingent upon those metaphysical commitments (Kendig and Grey 2019, 369).

Attributions of stability rely on choices based on the assumptions one holds about which possibilities are relevant to consider and which are not. Commitments to a particular way the world is or should be, are causally implicated by the choice made.

The choice of soil management strategies relies on farmers' perspectives and values embedded within these choices. What farmers consider soil to be, what soil should be, and what is their role in making bad soil good are causally implicated in the choice of soil management strategy they make. These values of what is good soil, a good steward, a good farmer are causally efficacious difference makers when it comes to making choices about soil management strategies. The reason they become causally efficacious difference makers is in virtue of the farmers' soil relationships and how these are captured by the haptic and visual metaphors they use in conceiving of them. As such, these sensory based metaphors are also value-laden insofar as they capture the types of relationality felt in soil-human interactions that are used in ontologizing practices. In this way, perspective impacts what farmers take to be important strategies to adopt, and which are considered to be less important to adopt. These valuations of strategies are informed by epistemic and non-epistemic values anchored to particular metaphysical representations of the world. The choice of soil management strategies depends on farmers' judgements about the relevance or irrelevance of their use for their soil goals. Good kinds of soil management strategies rely not just on those that fit to these soil goals, but also on their feasibility within the community, on the belief that these strategies will be those that can be stably maintained, and on the evaluation of these as the sorts of strategies a good farmer should adopt if soil care is the aim.

Considering the value-ladenness of farmers' soil management decisions in light of an integrated account of perspectival realism provides an opportunity to investigate the causal effects the holding of values has on farmers' decision-making activities around soil. The discussion of value-ladenness also shines a light on the causal impact social scientists' methodological decisions about how to categorize their subjects of interest into conspecific groups are also guided by values. These decisions rely on valuations such as what are the legitimate grounds on which to base categorizations and according to which values should the grounds for conspecificity be chosen, among others.

5. HUMAN-MANAGED SOILS AND SOIL-MANAGED HUMANS

One task that philosophers can pursue is analyzing whether the ontological categories used in research on soil management practices are apt for the purposes for which they are used. This is the project pursued in the first half of the paper. It began, investigating whether the empirical grounds on which the categories are based reflects the actual ecologies, cultures, and histories of community practices that inform farmers' soil management choices. It then analyzed different categorizations of perspectives, identities, and decision-making strategies of farmers around soil management used in recent social science and agricultural research. Following this, it examined how soil, soil management strategies, and land capability categorizations have been recategorized with reference to local ecologies and culturally situated farming practices.

Illustrating how ontological categorizations of soil management shape concepts relating to soil, the second half of the paper examined the concept of *soil health.* Conceptions of soil health were shown to covary with ontological categories of soil management in virtue of farmers' soil assessments which relied on soil type, previous yield, crop rotations, and the result of recent soil management strategies, local ecologies, anticipated weather events, and the history of agricultural activities that in their continued practice afforded the soils now present.

Expanding on this, I introduced a new interactive account of perspectival realism for soil management. To do this, I employed Chirimuuta's haptic metaphor to rework my own version of perspectival realism into an haptically interactive, practice-based account. My new interactive account of perspectival realism offers a haptic alternative to soil management ontologies empirically grounded in the practices of farmers as reported in farmer-focused and agricultural extension-based research studies. Farmer-focused research includes first-person accounts of how farmers work local land, interact with local ecological terrain, and are guided by cultural agricultural practices shared within communities and in the practices of neighbors. These accounts provide the means by which to grasp the multiply situated interactions that inform how farmers choose to manage local land and soil.

Studying these multiply situated interactions also provides empirical justification for a new reciprocal understanding of farmers' soil management decisions as those that are both cause and effect of soil. Decisions regarding how soils should be managed are shaped by the soils, their properties, and their perceived capabilities. Soils' properties in turn are the result of previous agricultural decision-making in light of culture, ecological terrain, crops intended to be planted, and values of farming held by decision-makers. The reciprocal causality of culturally and ecologically situated soil-human interactions means that in grasping what are human-managed soils, soil-managed humans are also grasped as the result of the co-managing relationship. Soil-managed humans are those whose future decisions about soil management are inextricably linked to the properties of the soil that is now in their hands. Bringing an interactive approach to perspectival realism to bear on soil management strategies also directs attention to the culturally and ecologically situated values of a "good farmer" and "good farming practices" embedded in the soil management choices farmers make. Exploring the value-ladenness of these choices, the paper concluded with an investigation of the values that are causally implicated in farmers' choices of soil management strategies.

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