DEFINING AND ASSESSING SOIL QUALITY. THE FARMERS' PERSPECTIVE.

Dr. Konstantinos N. Baginetas

Hellenic Republic, Region of Sterea Ellada (Central Greece)
Department of Agricultural Development
GR 35100, Lamia (kbaginetas@yahoo.co.uk)

Abstract

In this paper farmers' perceptions regarding the meaning of the term 'soil quality' are examined. Their views on what makes a good and a bad soil are also presented. Regarding the meaning of the term 'soil quality' farmers tend to focus on two characteristics of the soil – what can be seen (physical) and what can be seen plus the nutrients that can be seen added to it (physical plus chemical). Concerning what makes a good soil they pay more attention to the way the soil looks and the way it behaves while being cultivated and prepared for seedbed, and to whether they have to add fertilisers and lime to adjust the pH and nutrient status. In relation to what makes a bad soil the majority of these farmers judge a soil to be bad via visible material signs and tangible physical properties of the soil, such as sandiness and stoniness.

Key words: Soil quality, farmers' perceptions, participatory research

1. Intensification of agriculture and soil quality

Modern science-based agriculture, allowed producers to readily adopt a succession of mechanical, biological and chemical innovations that transformed agriculture into a powerful industrial machine that produces abundant food (Doran *et al.*, 1996). Intensified agricultural production systems used in the decades following World War II have managed to satisfy the demands of an increasing global human population (Schjonning *et al.*, 2004). However, they also had negative effects on the ecosystems involved, leading to a greater or lesser degree of deterioration or disturbance (Postel, 1994; Thompson, 1995; FAO, 1999). A major consequence of ecosystem disturbance is that of soil degradation (Oldeman, 1994; Conway, 1997; Karlen *et al.*, 1997a; Troeh *et al.*, 2004), which has been defined as the decline in soil quality caused through its misuse by human activity.

The decline caused on soil quality from intensive farming have led scientists to develop the concept of soil quality and to focus on the factors that influence the ability of the soil to function effectively within agro-ecosystems. Soil quality refers to the capacity of a soil to function, not only within its boundaries but also in the larger environment of which it is a part. It indicates the soil's fitness to serve (Harris and Bezdicek, 1994; Harris *et al.*, 1996) 1) as a medium to promote the growth of plants and animals (including humans), while regulating the flow of water in the environment, 2) as an environmental buffer that assimilates and degrades environmentally hazardous compounds; and 3) as a factor in enhancing the health of plants and animals, including humans.

Several definitions of soil quality have been proposed (Doran and Parkin, 1994; Doran *et al.*, 1996; Schjonning *et al.*, 2004; Lal, 2004). However, a widely-used definition is that offered by a committee appointed by the Soil Science Society of America, according to which soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (Allan *et al.*, 1995; Karlen *et al.*, 1997b).

2. The need for different research approaches regarding the definition and assessment of soil quality

Frequently, agricultural and soil scientists in their efforts to define and assess soil quality use a strict discipline-oriented, reductionist (positivist) approach (Kuhn, 1970; Rolling, 1994; Wynne, 1995; Pretty, 1995a; Schjonning *et al.*, 2004b). They restrict their interests and efforts to the discipline to which they belong epistemologically and they use the methodologies and tools with which they are most familiar (Norgaard, 1994; Roling and Wagemakers, 1998). Although this research methodology assists in establishing management approaches which optimise the multiple functions of the soil, conserve soil resources and support strategies for promoting soil quality, they nevertheless tend to propose definitions and assessment tools of soil quality (like sets of soil quality indicators) which are more likely to be extremely useful to

specialists (like researchers, consultants and conservationists) but which are beyond the expertise of a farmer to understand and use (Thapa and Weber, 1991; Hudson, 1992).

In response to this dilemma, Doran *et al.* (1996) and Doran (2002) suggested that the definitions and assessment tools chosen and developed should not only be available and accessible to a limited, select cadre of research scientists but also should easily be comprehensible and understandable by as many people as possible, especially farmers and managers of the land. In achieving this it is argued (Doran *et al.*, 1996) that the most appropriate approach to be used in defining and assessing soil quality must be a participatory one.

3. A shifting agricultural research paradigm. The need for scientist-farmer interaction

To meet this challenge, scientists will have to employ alternative research methods. Farmer participation, through the use of an inter-disciplinary research methodology, is a research approach for the development of a definition and of assessment tools of soil quality generally not used by scientists under the current discipline-oriented paradigm (Doran *et al.*, 1996).

The use of such farmer-participatory research approaches would force scientists to view agricultural problems from a farmer's perspective and, through an appreciation of the interactions and interdependencies within whole farms, scientists would develop a better understanding of the values that motivate farmers' production decisions resulting in research that more appropriately addresses farmers' concerns (Thornley, 1990; Watkins, 1990; Woodhill and Rolling, 1998; Lowe *et al.*, 1999; Bouma, 2004; Lal, 2004).

Through the use of participatory research methods farmers can be included as active participants in the research which can lead to the development of definitions and practical assessment tools of soil quality that are adapted to the producers' comprehension of the concept of soil quality, are easily accessible to the farmers themselves and useful to them within the context of their normal work routines (Sarrantonio *et al.*, 1996).

Moreover, agricultural ecosystems are multifunctional landscapes and they require research and management approaches that cross traditional discipline boundaries (Gliessman, 2000; Fry, 2001). A new research paradigm is needed in which the importance of the scientific knowledge of the biological and physical functions that operate within an agro-ecosystem is combined with the culture and people's perceptions of these functions, allowing the different stakeholders to express their visions (Haines-Young, 2000).

Within this context, it could be argued that with farmer participation, an appropriate soil quality definition and accessible assessment tools can be developed which will be meaningful to the producers' understanding of soil and soil processes. However, within the literature, instances of farmers actively contributing to the development of soil quality definitions and assessment tools are very few. This paper, based on a participatory research approach, presents the farmers' understanding of the term 'soil quality' and their perceptions regarding what makes 'a good' and 'a bad soil'. It also compares the farmers' perceptions with those of the scientists, in order to identify similarities and differences between these two groups of agricultural actors regarding the definitions and assessment of soil quality.

4. Research methodology

The research involved the conduct of semi-structured interviews with 36 farmers (between March and June 2003) in Nottinghamshire, England. The sampling strategy used to address the research questions of this study was theoretical and purposive sampling (Strauss and Corbin, 1998).

The material from the interviews and from the interview diary was transcribed as soon as possible after each interview was conducted. Every transcript was read through after the transcription to identify themes (after Coffrey and Atkinson, 1996) and the analysis involved going through the material thematically to determine codes and categories responding to perceptions that informed the farmer's views regarding the research topic (Crang, 1997). For respondent validation, 18 of the farmers were contacted and all agreed to meet again and go through the interview transcripts. These interviews were held between September and October 2003.

This paper focuses on the themes emerging from the farmers' responses to the following questions:

- **"Many scientists use the term "soil quality" to describe the state of a soil. What does it mean to you?"**
- **"In your opinion, what makes a good soil?"**
- **"In your opinion, what makes a bad soil?"**

Of the 36 farmers interviewed (all the farmers interviewed were male. Attempts were made for female farmers to be interviewed without success), 34 were 'born' (following family tradition) in agriculture and only 2 of them had families that were not directly involved with farming. Of these, 21 had attended an agricultural college and 15 had learned through experience and by working with their fathers and grandfathers on the family farm. 21 of the farmers were practicing mixed farming, 12 arable farming and 3 dairy/beef farming. 29 of them were using conventional methods of farming, 6 organic and 1 biodynamic (biodynamic farming is a type of organic farming. It differs in the use of fermented preparations in compost and as field sprays, von Keyserlingk, 1999). Of the farmers 14 had been practising farming for 20 to 29 years, 12 for 30 to 39 years, 6 for 40 to 50 years, 3 for 10 to 19 years and one for 5 to 9 years. 15 of the farmers had a farm of between 100-199 ha, 11 of between 200-299 ha, 6 of between 300-399 ha, 3 of more than 400 ha and one of less than 100 ha.

5. The meaning of the term 'soil quality' to farmers

Regarding the meaning of the term 'soil quality', farmers were divided into three main groups (*Table 1*).

What does it mean to you?	Soil texture (soil type)	Ability to grow a crop (yield)	Classification (grades)	Humus/organic matter level	Various properties (mixture*)
Number of farmers	13(2 org)	7	3	3	10(4 org, 1 biod)
Percentage (%)	36.1	19.4	8.3	8.3	27.8

*: Soil structure, pH, organic matter, phosphorus, potassium, free from compaction, not water logged, drainability etc.

Table 1. Summary of farmers' answers to the question: 'Many scientists used the term 'soil quality' to describe the state of a soil, what does it mean to you?'

The biggest group (13 out of 36) considered soil quality to mean soil texture or type (sand, silt, clay or loam); "*Well, I always thought it was describing the soil type, so depending on whether it's a sand or whether it's a clay and obviously there is a, there is a mixture in between*" (Farmer No4) (The number provided after the word 'Farmer' indicates the serial number of the conducted interviews. For example Farmer 3 means the farmer interviewed third in the row, etc).

Ten farmers considered the term 'soil quality' in direct relation to a mixture of properties in it; "*Soil quality, hem, it depends on the loam in the soil, how heavy it is, its ability to hold water, its ability to drain easily in wet conditions, … and the nutrient contents of the soil … if it's covered with a variety of weeds, … if it's got residues of chemicals in it from previous farmers it's just depends on a few, a few different things*" (Farmer No30).

The third group (7 farmers) understood 'soil quality' to mean the ability of the soil to produce a crop; "*To me a soil is graded in its ability to produce a particular crop, whatever that crop might be or a range of crops even*" (Farmer No3).

There were also two smaller groups (three farmers in each) that considered soil quality in relation to humus/organic matter level in it, "*Quality basically is I think, simply is the humus level I think*" (Farmer No5) or by referring to the classification system used in England (grade 1, grade 2 etc.) "*Well you see we grade soil on grade 1, grade 2 or grade 3, we grade the soil that way, the tougher it gets higher it gets in the score*" (Farmer No8).

Summarising, the term 'soil quality' seems to have various meanings to farmers. When asked to produce a definition, they tend to focus on two characteristics of the soil – what can be seen (physical) and what can be seen plus the nutrients that can be seen added to it (physical plus chemical). In other words, to most of them, 'soil quality' is identified with the visible aspect of the soil, namely with the soil type or texture of the soil and, to a lesser degree, with the fact that soil is a blend of physical and chemical properties. It is interesting to note though that none of the farmers referred to the biological aspects of the soil (earthworms or other living organisms in it), although three mentioned this as a part of the characteristics of a good soil (see below). Also many farmers seem to connect the term 'soil quality' with the ability of the soil to be able to establish and grow a good crop which ultimately leads to increased monetary returns.

6. Farmers' perceptions on what makes a good soil

Regarding what makes a good soil farmers' answers were divided into three main groups (*Table 2*).

What makes a good soil?	Combination of physical and chemical properties*	Workability	The ability to grow good crops/yields	Friability	Combination of physical, chemical and biological properties**	All soils are good
Number of farmers	18(4 org)	7(1 org)	5	2	3(1 biod, 1 org)	1
Percentage (%)	50	19.4	13.9	5.6	8.3	2.8

*: Drainage, humus, moisture retentive, deep soil, loamy, organic matter, nutrients, pH

**: Drainage, humus, moisture retentive, deep soil, loamy, organic matter, nutrients, pH, earthworms, bacteria, fungi

Table 2. Summary of farmers' answers to the question: 'In your opinion what makes a good soil?'

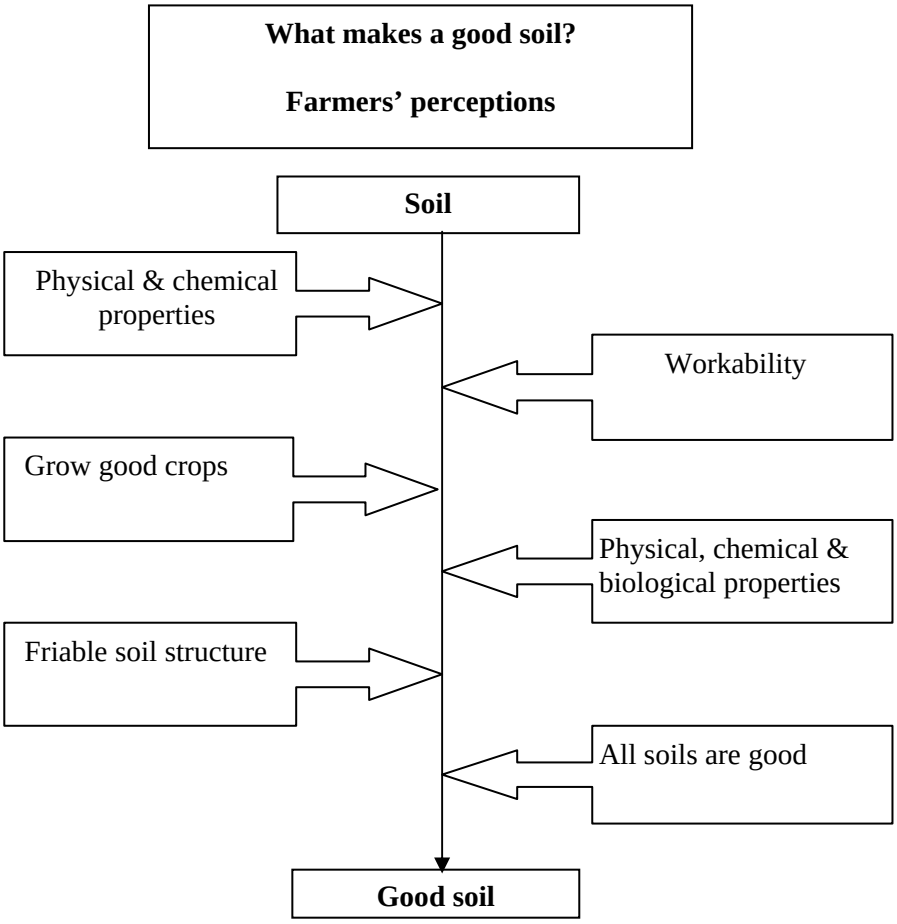

Figure 1. Factors that affect farmers' definition of a good soil (source author)

Half the farmers (18/36) cited a combination of physical and chemical properties that a good soil should have "*Well, free draining, available nutrients, pH got to be right, not to be eroded away*" (Farmer No2).

Seven farmers considered a good soil to be one that is easy to work with; "*A fertile soil for a start and then one easy to manage*" (Farmer No19) (org).

Five farmers defined a good soil as one that has the ability to grow good crops and big yields; "*It's ability to grow crops, one that will give you a nice crop*" (Farmer No7).

Two farmers stressed friability, three mentioned a combination of physical, chemical and biological properties and one said that all soils are good.

Summarising, most of the farmers consider how good a soil is by focusing primarily on the physical and the chemical properties of it. They pay a lot of attention to the way the soil looks and the way it behaves while being cultivated (especially during the various tillage practices with the use of a tractor) and prepared for seedbed, and to whether they have to add fertilisers and lime to adjust the pH and nutrient status (and

how much of these). Notably there are very few mentions of any biological properties of the soil, like earthworms, bacteria etc. Most of the farmers focus on pH tests and fertility tests and restrict their soil-improvement actions mostly to adding fertilisers (macro- and micro-nutrients) and lime. Some farmers classify a soil as good according to its capacity to produce good, big and diverse crops, and provide them with good returns and profits. *Figure 1* depicts a representation of the main factors that affect the farmers interviewed and the definition they give of a good soil.

7. Farmers' perceptions on what makes a bad soil

The farmers were also asked what they thought made a bad soil (*Table 3*).

What makes a bad soil?	**Combination of physical and chemical properties***	**Workability**	**Combination of physical, chemical and biological properties****	**All soils are good**
Number of farmers	29(4 org)	3(1 org)	3(1 biod, 1 org)	1
Percentage (%)	80.6	8.3	8.3	2.8

*: Sandy, light, heavy clay, water logged, no fibre, compacted, no nutrients, no organic matter, cold, poor drainage, acid

**: Sandy, light, heavy clay, water logged, no fibre, compacted, no nutrients, no organic matter, cold, poor drainage, acid, chemical residues, earthworms, bacteria, microorganisms

Table 3. Summary of farmers' answers to the question: 'In your opinion what makes a bad soil?'

The majority of the farmers described a bad soil using a combination of physical and chemical soil characteristics; "*A tend to, well to be non productive. It's either very sandy, very stony, very dry, very wet, very low organic matter and prone to erosion and compacted, these sort of things*" (Farmer No2), "*Heavy clay, unfree draining, covered the soil certain residues as chemicals left over which are now banned, all kinds of staff, compaction rates, that kind of thing*" (Farmer No30).

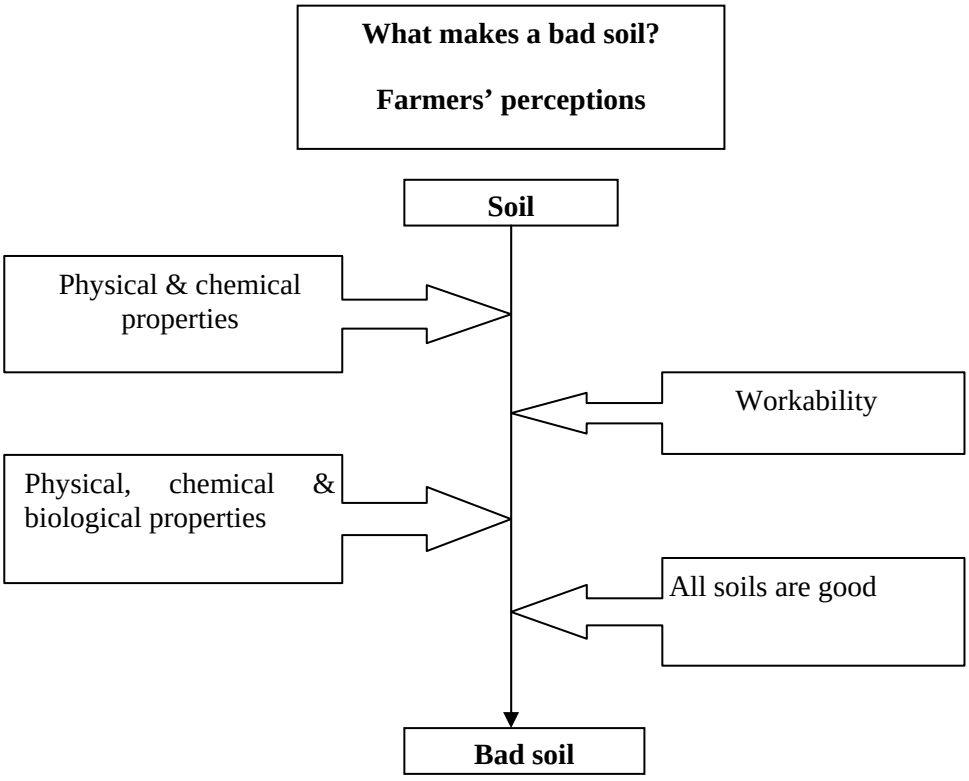

Figure 2. Factors that affect farmers' definition of a bad soil (source author)

Summarising, the majority of these farmers judge a soil to be bad via visible material signs and tangible physical properties of the soil, such as sandiness and stoniness. They pay less attention to the chemical properties and even less to the biological properties of soil. Indeed it appears that in the case of 'soil badness' they take a greater variety of physical aspects like type, structure, compaction, drainage etc., a smaller range

of chemical properties, mostly the nutrients and the pH, and even fewer biological features (mostly earthworms), than with 'soil goodness'. *Figure 2* depicts a representation of the main factors that affect the farmers' answers regarding the definition they give of a bad soil

8. Comparing farmers' and scientists' views

From the research findings it can be argued that the farmers interviewed consider soil quality in relation to three main aspects 1) the soil texture or type, 2) the various soil properties (such as soil structure, pH, organic matter, drainability etc.) and 3) the ability of the soil to produce a crop.

On the other hand, the definition produced by the Soil Science Society of America (SSSA) and accepted by many scientists (as seen above) focuses on different aspects of the soil.

Comparing the two definitions of soil quality, it can be argued that farmers tend to focus on specific, tangible and observable aspects of the soil (its properties and in particular its texture and the production obtained from it), as also reported by Andrews *et al.* (2003), while scientists tend to try to include multiple dimensions of the role of the soil. In this case, the difference between the farmers' and the scientists' definitions could relate to what McEachern (1992, p.168) referred to as '*clash of cultural constructions*'. It can be said that these farmers are following a different reasoning to the scientists, when trying to give a meaning of the term 'soil quality'. Instead of trying to include a broad spectrum of developed scientific knowledge into an 'all-encompassing' definition, they are using the 'specific knowledge' that they have gained from working on their specific farm and with their specific soil, to express their opinion and relate their answers to specific aspects that they are very familiar with and comfortable talking about (Romig *et al.*, 1995; Sillitoe, 1998, Winklerprins, 1999; Tsouvalis *et al.*, 2000; Boardman *et al.*, 2003).

When focusing on the nature of a good or a bad soil, the farmers expressed their views by providing examples of how a good or a bad soil looks and behaves. In doing so, they focused on various soil properties. This way of reasoning coincides with the way that scientists tend to distinguish between qualities of soils; through the use of lists of specific soil properties (Doran and Parkin, 1994; Doran *et al.*, 1996; Karlen *et al.*, 2001).

However, the way the farmers distinguished between a good and bad soil differed from that of most scientists in two main ways 1) in that they focused mostly on physical and chemical soil properties, as opposed to physical, chemical and biological properties and 2) in that they were based on descriptive, on-farm observations rather than (laboratory) quantification of the soil properties.

9. Conclusions - Recommendations

There has been much debate in academic literature about the definition of 'soil quality' (Doran and Parkin, 1994; Karlen *et al.*, 2001), but not much attention has been paid to farmers' accounts and their own '*intimate knowledges*' (Tsouvalis et al., 2000, p.912). The findings of this research suggest that there is a need to promote and enhance the active participation of farmers in issues and schemes aiming at the definition and assessment of soil quality (Chambers, 1993; Pretty, 1995b).

In addition, the farmers' 'soil theories' and perceptions, which affect their decision-making, need to be better understood in order to develop soil quality assessment tools (like soil quality indicators) that are relevant and meaningful to them (Nazarea *et al.*, 1998; Morrone and Hawley, 1999; Niemeijer and Mazzucato, 2003). As the above research showed, these farmers depend a lot on the physical and tangible aspects of soil and on their experience and skill when they are assessing its quality. A move from top-down research and policy approaches is necessary in order to develop meanings and tools that '*make sense*' (Nazarea, *et al.*,1998, p.159) to farmers and are relevant to their farming realities and concerns.

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