# SUSTAINABILITY: SEEING THROUGH THE EYES OF FARMERS.

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## ABSTRACT

In the Netherlands, the agricultural sector is facing a major challenge, which is the transition towards a sustainable agriculture. The discussion thus far has been at a conceptual, macro level. A more deep approach to sustainability involves examining who is using this term, and how. For example, how does sustainability operate at the farm level? Hence, it is relevant to investigate the knowledge processes of the main actors in agriculture: farmers. For knowledge processes, we mean the processes that (individual) farmers undertake to understand the information they receive. These processes are divided in two domains, static domain, which deals with the way an individual structures knowledge; and dynamic domain, which deals with the thinking processes of an individual. Our study proposes to explore the two domains of knowledge held by farmers in the Netherlands. Individual structures of knowledge will be explored through cognitive mapping exercise. Thinking patterns will be explored through protocol analysis. Both the cognitive maps and the protocol analysis have to be analyzed to reveal commonalities and differences among farmers. This manuscript contributes to research on knowledge of sustainability, which has barely penetrated discussion within the agricultural sector. It shows cognitive mapping and protocol analysis might be effective techniques for investigating the meaning of a subject like sustainable agriculture.

## KEYWORDS

Agriculture, Cognitive Mapping, Knowledge, Sustainability, Protocol Analysis.

## INTRODUCTION

Several authors have revised the conceptual development of the sustainability concept (Ikerd, 1990; Hansen, 1996; Mebratu, 1998; Faber, 2006). There is some consensus in the fact that the different definitions discussed in the literature include - at different extent- three basic elements: the natural environment, economical profits and the welfare of the society. Elkington (1994) grouped these elements and coined the concept of the "Triple Bottom Line or 3P's" (People, Planet, and Profit). Judgments according to a sustainability standard are not absolute, but require a contextual matter (Norman and MacDonald, 2004). In other words, to talk about sustainability or sustainable development requires adapting the concept to a context. We will situate the discussion over sustainable development in the context of agriculture. Given the importance of

agriculture as the ultimate provider of food, fiber, and shelter for human population, no sector has such an important role in moving towards a sustainable future (Smith and McDonald, 1998).

Despite significant scientific and technological achievements to increase agricultural productivity, there has been much less attention to some of the unintended social and environmental consequences of human achievements. Agriculture is one of the key sectors to prevent environmental damage projected to 2030 (OECD, 2008). The European Union -and therefore the Netherlands- now places less emphasis on production than in the past and more on maintaining quality and on the roles and incomes of individual farmers. Agriculture is a system manipulated by humans, and then in accordance with Faber (2006), the functioning of the agricultural system is correlated with the behavior of the humans on whom it depends. Hence, the sustainability of the agricultural system depends on the knowledge of the farmers who determine the system's functioning. If the meanings over sustainable development are already diverse, some questions arise: What do farmers mean by sustainable? Moreover, what knowledge do they have concerning sustainability? In terms of research in the agricultural context, studying farmers' worldviews seems useful to answer these questions. In the next section, we will explain the approach that will allow us to answer these questions.

## KNOWLEDGE APPROACH

Knowledge is something that individuals have and exhibit in all kinds of activities. In the Western world, philosophical debates about knowledge in general start with Plato's formulation of knowledge as "justified true belief." Although this formulation is questioned, we will not discuss the history of philosophy on knowledge. Our understanding of knowledge is cognitive oriented which considers that knowledge builds on information that is extracted from data (Boisot, 1998). Fundamental to the study of knowledge is the notion that individuals hold that knowledge within structures within their cognitive or mental system. According to Jorna (2007), the crucial distinction between information and knowledge is interpretation. This activity is carried out by people as an information processing system (Newell and Simon, 1972) consisting of cognitive architecture (mental representations) and processes on these representations. Internal representations or mental objects reflect the content of a person's knowledge and are located in cognition and ultimately in the brain. In studying human cognition, researchers examine human cognitive processes through mental representation. The cognitive structure or architecture is the first core element in a theory of human cognition (Newell, 1990). The concept of cognition offers the link to study the knowledge structure that people use to make assessments, judgments, or decisions involving opportunity evaluation and venture creation and growth. The second core element is the content, available in terms of mental representations, cognitive representations, and models.

According to Jonson-Laird (1983) individuals construct mental models (mental representations) of the world and they do so by employing, mostly tacitly, mental processes. There are recursive mental processes that enable human beings to understand

discourse, to form mental models of the real and the imaginary and to reason by working on and manipulating such models.

A mental model consists of three steps:

a) Translation of some external processes into an internal representation (in terms of words numbers and other symbols).
b) Derivation of other symbols by some sort of internal process.
c) A new translation of the derivate symbols into action.

Jonson-Laird exemplifies the difference of models among different persons. In discussing views on TV's he discerns:

a) An average TV viewer: A box with images
b) A person who repairs TVs: A cathode ray firing electrons at a screen
c) A circuit designer: Electrons as negatively charged particles moving on a magnetic field.

For the discussion on sustainable agriculture, we use the same perspective of mental models. Individuals and organizations incorporate their own understanding of sustainable agriculture into various aspects of their operations. We can exemplify how people may think about soil:

a) An average person: It forms a thin layer over the surface of the earth.
b) A fertilizer's supplier: It serves as a substrate supporting plant growth and as a nutrient reservoir.
c) An agricultural engineer: It is essential for crops. It is not only a support for plant roots, but also the site of many physical, chemical, and biological processes.

We argue that in order to explore the meaning of sustainable agriculture a knowledge approach can be used. McElroy (2008) identifies knowledge as the key factor regarding sustainability. Such knowledge approach focused on the farmers is hardly found among the literature on sustainable agriculture. Laukkanne (2000) explores the notion of sustainability of the structure and dynamics of different municipalities in Finland as social entities and micro economies. In New Zeeland, Byrch et al. (2007) explored the meaning of sustainable development held by business leaders who promote sustainability. Regarding agriculture, Boone Jr. et al. (2007) reported the knowledge that extension educators have concerning the dimensions of sustainable agriculture. Farmers can be considered as human information processing systems. Human decision-making involves two components Newell and Simon (1972). First, we have the farmer personal characteristics. In this respect, there have been studies regarding the characteristics (or traits) that influence farmers in order to adopt (or not) specific farming practices (Lauwere et al. 2004). In second place, his personal knowledge processes regarding farming practices. For knowledge processes, we mean the processes that (individual) farmers undertake to understand the information they received. These processes are divided in two domains, static domain, which deals with the way an individual structures

knowledge; and dynamic domain, which deals with the reasoning processes of an individual (Figure 1).

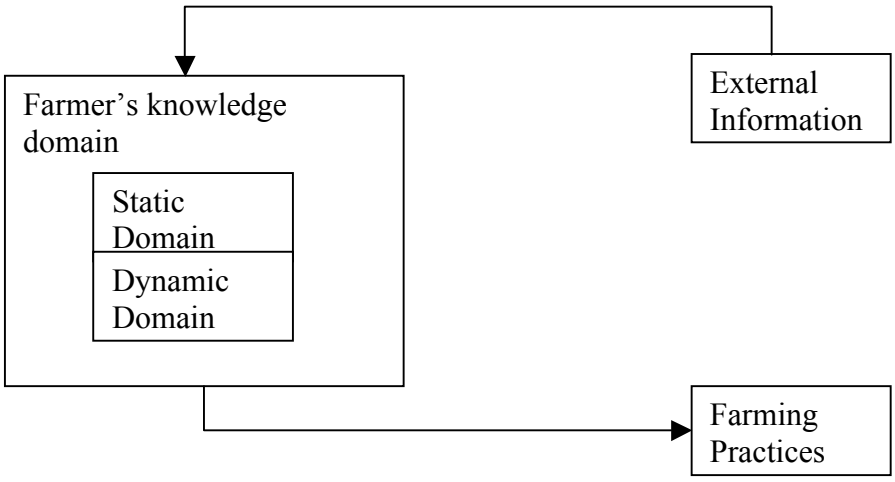


Figure 1. Farmer's knowledge processes

**STATIC DOMAIN OF KNOWLEDGE**

The study of the static domain allows identifying the associated concepts with sustainable agriculture. We have developed a list of 31 concepts expected to be in farmer's mental models (Table 1). These concepts refer to one of the 3P's (People, Profit, Planet). The concepts are used to elaborate a cognitive map. Cognitive mapping is a technique, which has been used to structure, analyze, and make sense of accounts of problems. The theory suggests that individuals make sense of the world in order to predict how the world will be in the future and to decide how individuals might intervene in order to achieve what they prefer within that world (Kelly, 1955).

Table 1. Concepts used to elaborate cognitive maps

| CONCEPTS | 3 P's |
|---|---|
| Soil Fertility<br>Crop Rotation Scheme<br>Nitrogen<br>Phosphorous<br>Fertilization Plan<br>Soil Nutrient Analysis<br>Soil Pathogen Analysis<br>Soil texture<br>Organic Matter<br>Water (irrigation)<br>Energy (fuel)<br>Nature<br>Crop Residue | Planet |
| Production Cost | Profit |

| | |
|---|---|
| Sales Price<br>Revenue<br>Crop Yield<br>Product Quality<br>Market | |
| Training (Study Group)<br>Consumer's opinion<br>Colleagues' Opinion<br>Supplier's opinion<br>Local Community<br>Public opinion<br>Family<br>Future generations<br>Regulation<br>Wellbeing<br>Independent Advisor<br>Legislation (CAP) | People |

**DYNAMIC DOMAIN OF KNOWLEDGE**

The dynamic domain allows distinguish mindset orientations as well as reasoning patterns. In the literature of sustainability, it is found that a systemic approach is needed if one studies sustainable issues. The study of (sustainable) agricultural systems should be based on an approach that allows looking for connections among all aspects of these systems (an overall and integrated or, what we also call systems, approach). A systems approach provides an overview and manner of understanding how the different relationships on a specific context work. A system can be technically defined as a set of components functioning together as a whole. A systems view allows isolating a part of the world and focusing on those aspects that interact more closely than others do. System thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than snap shots. The core of systems theory is based on the understanding of the concept of feedback that shows how actions can reinforce or counteract (balance) each other (Weinberg, 1975). Based on system's theory in Table 2, we present concepts that can be used to distinguish a sustainable oriented mindset from the mindset of classical farming.

Table 2. Elements of a sustainable oriented mindset on an agricultural system

| **Less sustainable oriented mindset** | **More sustainable oriented mindset** |
|---|---|
| Focus only in specific units of the system | Focus on the Big Picture of the system (holism) |
| Focus on "straight" chains in the system | Focus on interconnections within the system |
| (Lack of) focus on different interactions | Focus on feedback loops among units |
| Working on isolation or on a hierarchical manner. | Cooperation |
| Short time perspective (here and now) | Long time perspective (there and then) |

In Table 3, four levels of evaluation for every element included in Table 2 are presented. The criteria are possible to identify on a protocol given by an interviewee. Protocol analysis is a research method that elicits verbal reports from research participants. Protocol analysis is used to study thinking in cognitive psychology and cognitive science. It has also found further application in the design of surveys and interviews (van Someren et al., 1994).

Table 3. Evaluation of Reasoning Patterns

| **Elements** | **Level 1 Interviewee…** | **Level 2 Interviewee…** | **Level 3 Interviewee…** | **Level 4 Interviewee…** |
|---|---|---|---|---|
| **Big Picture/ Holism** | does not see a dilemma.<br>lacks interest. | has a difficulty to see the dilemma.<br>does not see solution for the dilemma. | designs a plan to tackle the dilemma. | describes several plans to tackle the dilemma. |
| **Time Horizon** | does not see any problem. | focuses on events that affect here and now. | focuses on events on the near future. | focuses on events that affect there and then. |
| **Interconnections** | lacks information. | predicts results.<br>identifies benefits or downside costs.<br>is aware of concepts related to one of the 3P's. | predicts possible troubles.<br>balances benefits vs. downside costs.<br>is aware of concepts related to two of the 3P's. | predicts how to overcome troubles.<br>balances benefits and reframed view of costs.<br>is aware of concepts related to the 3P's. |
| **Feedback** | identifies only the symptoms of dilemma.<br>does not find relationships. | identifies personal consequences.<br>connects elements of the system as one way (cause-effect). | identifies consequences for others.<br>represents a circular causal relationship between two elements. | identifies consequences for others.<br>represents a causal relationship among more than two elements. |
| **Cooperation** | knows a part of the system perfectly. | thinks about the possibility of other opinions. | takes other's points of view | shows flexibility to adapt other points of view into his own view. |

## EXPERIMENTAL DESIGN

The knowledge of sustainability in agricultural activities from several farmers will be evaluated. Farmers are expected to construct maps of their understanding of sustainable agriculture. Individuals will be given a written introduction where the next question is posed: "Thinking about your main product, which factors are the most relevant while you are planning your next sowing season?" We expect that farmers that are prone to sustainable have more complex maps than those who do not favor sustainable practices. We have also developed an instrument to gauge the systemic qualities of a farmer's thinking. Farmers will solve agricultural-based problems and what they have to say as they think aloud will be recorded. We have designed problem scenarios life-based and we will assess their responses according to the concepts listed in Table 3. The stories are designed to gauge the systemic elements in the farmer's mindset. Once the interviewees solve the two tasks we may use qualitative analysis to elaborate an interviewee's mindset profile. Table 4 shows a sample profile for a farmer that has a sustainable mindset.

Table 4. Sample profile of a sustainable mindset

| | **Level 1** | **Level 2** | **Level 3** | **Level 4** |
|---|---|---|---|---|
| **Big Picture/ Holism** | | | | **V** |
| **Time Horizon** | | | **V** | |
| **Interconnections** | | | **V** | |
| **Feedback** | | | **V** | |
| **Cooperation** | | | | **V** |

## CONCLUSIONS

The goal of developing sustainable agriculture is the responsibility of all participants in the system, including farmers, laborers, policymakers, researchers, retailers, and consumers. Each group has its own part to play, its own unique contribution to make to strengthen the sustainable agriculture community. Agriculture has been considered through the years as having the specific function of production where the main objective is to produce commodities (food and fibers) and the main goal has been to increase the land productivity in order to provide more food and to have more economic profit. This model drove achievements of knowledge in Europe after World War II and the spread of the green revolution beginning in the 1960s. Nowadays there is increasing recognition that the current agricultural model requires revision. This leads to rethinking the role of knowledge in achieving development and sustainability goals within agriculture. We propose a knowledge approach to study sustainable agriculture. Knowledge as a criterion for guiding agriculture as it responds to change. We believe that considering the concepts that farmers include in each model of farming practice will help the transition from a conventional to a sustainable agriculture. The different worldviews in classical and sustainable agriculture can and should be studied and evaluated more intensively. In this paper, we have presented a cognitive approach towards sustainable agriculture. Through this approach, we aim at identifying concepts linked with sustainable agriculture (static

knowledge domain). We believe, this approach also allow us to get some insights in the way of reasoning among the interviewees (dynamic knowledge domain).

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