A call to focus on farmer intuition for improved management decision making

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Abstract

Mainstream agricultural research takes a rational approach to generate, empirical, tangible knowledge for increased yields and sustainability. This approach has led to the development of technological tools to support farmers in their management decision making, which, while helpful, are not able to factor in the complex, dynamic variables that motivate farmer decision making. More importantly, farmers often do not adopt these tools as expected.

Could a solution lie in considering other sources and types of agricultural knowledge? Some farmers report relying largely on intuition (knowing from within) to inform their practical management decisions, resulting in both qualitative and quantitative benefits. Intuition allows access to valuable tacit (informal, intangible) knowledge, which can be used to explore and apply more resilient agricultural practices. It is an immediate and valuable part of decision making, and deserves more attention from both farmers and researchers.

This paper discusses potential advantages, challenges to, and methods of mainstreaming farmer intuition, and presents appropriate methodologies for its development, emphasizing the need to expand the underlying ontology and epistemology of the mainstream scientific community.

Keywords: farmer decision making; farm management; tacit knowledge; holistic decisions; resilient farming systems

1. Introduction

Farmers are increasingly pressured to make management decisions that are both efficient and ecologically robust. However, the reasoning and values behind these decisions are more individualistic than has been appreciated. A review of 55 studies spanning 25 years of literature in the United States was inconclusive as to which factors consistently determined farmers' reasons for adopting best management practices (Prokopy et al., 2008). Furthermore, a synthesis of 31 empirical analyses on farmer adoption of conservation agriculture found few variables that universally explained farmers' motivation to adopt certain practices (Knowler and Bradshaw, 2007). So how do farmers make management decisions, and especially those that consider longer-term ecological and social consequences?

Applied ecological knowledge arises not only from formal scientific study, but also through farmers' experiential learning from interactions with their agroecosystems, leading to context-specific knowledge that draws on local resources rather than more generalised and widely applicable solutions (Altieri, 1995). So, perhaps the key lies in widening the recognition of, access to, and application of different types and forms of knowledge (Curry and Kirwan, 2014; Code, 2018).

2. Different sources of knowledge in agriculture

2.1 Examining the mainstream sources of knowledge in agriculture

The dominant ontology (belief about the nature of reality, or how the world is) and epistemology (belief about the grounds for human knowledge, or how the world can be known) of the mainstream agricultural paradigm is largely positivist, in that all matter and processes can be reduced to concrete matter. It looks to modern (Newtonian-Cartesian) 'Western' science

to provide knowledge, accumulated through observable data gathered in controlled and repeatable experiments (van Eijk, 1998). This results in explicit knowledge, i.e. formal knowledge that can be articulated, documented, codified, and easily transferred in a systematic and tangible form using words, numbers and formulae, and disseminated through, for example, instruction manuals (Boateng, 2006; Nonaka and van Krogh, 2009; Vangala et al., 2014).

The paradigm shift called for in the United Nations Conference on Trade and Development (UNCTAD) Trade and Environment Review (2013) report invites examination of how knowledge that is thought by modern science to be appropriate for sustainable agriculture is generated and used. Going further, van Eijk (1998) and Code (2018) identify the need to question the ontology and epistemology of mainstream agricultural research, and to recognise and include the role of interior knowledge sources.

This has been addressed, to some extent, when agricultural research began to acknowledge the constructivist paradigm (constructed nature of reality) in the 1980s (van Eijk, 1998), including through the exploration of indigenous research methods (Apusigah, 2011; Chilisa, 2012). However, tacit knowledge still has not yet been significantly addressed (van Eijk, 1998; Boateng, 2006; Curry and Kirwan, 2014; Vangala et al., 2014). Tacit knowledge is intangible, personal, often experiential and informal in nature, involving conscious and unconscious awareness of perspective, personal beliefs, values and innate knowing. It is found in traditions, customs and *savoire-faire* (adaptive ability to determine appropriate action). It can refer to the decision rules stored in the mind, but is implicit in nature and cannot always be articulated, codified, or transferred. Yet it can be accessed through intuitive processes (Boateng, 2006; Nonaka and van Krogh, 2009).

2.2. Value of using intuition in decision making

Dane and Pratt (2007) define intuition as 'affectively-charged judgements that arise through rapid, non-conscious, and holistic associations', or 'the provision of a conclusion reached without formal analysis'. Perhaps a simpler and more apt definition of intuition is 'knowing without knowing how you know', or 'knowing from within' (Hodgkinson et al., 2008). To date, most evidence on the value of intuition comes from the fields of psychology and business management, and is recognised as critical in hyper-competitive business environments (Harvey et al., 2002) and clinical judgement in medicine (Chin-Yee and Fuller, 2018).

In the field of economics, Kahneman (2003) observes that decision makers are aware of limited information, and most judgements and decisions are made intuitively. He presents a map of 'cognition architecture', in which the characteristics of intuitive and reasoning (rational/logical) systems are summarised. Here, intuition resembles perception, and both are fast, automatic, associative, and reference-dependent, or stimulus-bound. Reasoning, by contrast, is slow, controlled, and neutral, and both intuition and reason are informed by experience. He emphasises that intuition can be powerful and accurate, but applying it effectively requires prolonged practice. Given our perspective on the constructivist, subjective nature of reality, we would contend Kahneman's (2003) identification of reasoning as being neutral.

Overall, intuition appears to be an involuntary, immediate and inevitable part of all decisions, which can complement logical cognition, and can be highly useful when there is a time constraint on gathering (potentially unreliable) information (Khatri and Ng, 2000). It can boost accuracy, confidence, and speed in the decision-making process (Lufityanto et al., 2016). This suggests that applying intuition, and thus accessing tacit forms of knowledge, holds potential for improved farm management decision making

2.3 Learning from traditional and indigenous ecological knowledge systems

Many traditional and indigenous cultures worldwide have evolved a highly integrated, holistic, intuitive understanding of the complex natural systems in which they live, and maintaining a dialogue with these systems is crucial for managing food production landscapes (Parry, 2005; Apusigah, 2011). Small-scale and subsistence farmers use their tacit understanding to adapt to increasingly unpredictable climatic conditions, such as drought, thereby increasing the resilience of their agroecosystems (Kieft, 2006, 2015; IAASTD 2009; Makondo and Thomas, 2018). Resilience (the ability to remain functional under stress) is an important criterion of health and adaptability in agricultural systems (Döring et al., 2013), and is crucial for farmers to consider in their decision making, especially in regions with rapidly-changing climatic conditions.

This 'situational knowledge' (Haraway 1988) is generated through experience, language, culture and tradition *in situ*, and through more than the five physical senses. These stocks of intuition, or cultural capital (Hogarth, 2010), are the product of tacit learning, and expand on, and contribute to, a more holistic, pragmatic knowledge base than the (explicit) knowledge gained through modern science's overemphasis on the sense of vision and observation.

Several global organisations have called for the protection and utilization of these knowledge systems, arising from their value in evolving adaptive agricultural solutions and addressing global food security. For example, in 2002, the Food and Agriculture Organization initiated the Globally Important Agricultural Heritage Systems (GIAHS) programme, to safeguard and support indigenous and traditional knowledge systems at risk of disappearing through the spread of industrialised agriculture. GIAHS policy suggestions are already being applied, as in the case of the inter-university initiative Capacity and Theory Building of Universities and Research Centres

on Endogenous Development (CAPTURED), which has formulated curricula to include ancient wisdom and intuitive knowing into higher education (Haverkort, 2010).

2.4 Potential risk of externalising tacit knowledge

Organization science places both explicit and tacit knowledge along a continuum, and considers that the less extreme forms of tacit knowledge may be externalized or converted (Nonaka and van Krogh, 2009), to allow for the expansion of knowledge beyond what exists in one individual or community. Through participatory research approaches, some tacit knowledge embedded in traditional and indigenous ecological knowledge systems has been externalised for improving and developing sustainable agricultural practices (Eastwood et al., 2012; Curry and Kirwan, 2014). Steps such as the GIAHS programme contribute greatly to understanding and using the various knowledge bases of farmers worldwide. However, apart from the innate difficulty in expressing tacit knowledge, building mutual trust for an effective 'dialogue of wisdom' with those holding tacit knowledge is not easy. Knowledge holders may be reluctant to share with western scientists, expressing a lack of confidence in its appropriate use outside of their own cultural and spiritual context. For example, knowledge about local plants shared with researchers of international seed businesses has often been exploited for profit (Henk Kieft, personal observation).

Additionally, because such embedded knowledge is situational, practices developed from them are appropriate to local cultures and regional conditions, and not well suited to adapting to, or scaling up within, other cultures and regions (Chilisa, 2012). And because of the internal, experiential nature of both intuition and tacit knowledge, an externalisation process could alter or dilute the value of such knowledge (Hodgkinson et al., 2008).

This location-specificity is at odds with the positivist paradigm of mainstream agriculture. Could support for farmers to individually access and apply tacit knowledge circumvent this? Certainly, farmers would be imbued with more agency and autonomy than is currently the case.

3. Reviewing the role of intuition in farmer decision making

To assess how existing agricultural research addresses intuition in farmer decision making, we performed a search on the scientific databases Scopus and Web of Science, cross-referencing the keywords 'intuition' with 'agriculture' and 'farming'. Filtering 60 search results for relevance to management decision making yielded a total of seven papers, all published in the 16 years up until 2019. We included a further two articles from conference proceedings.

3.1 The need to reconsider the analytic approach to supporting farmer decision making

Five of the seven articles from our initial search were associated with the development and use of analytical decision support systems in industrialised countries. Using a rational/logical approach based on cognitive task analysis, formal tools using information communication technologies have been developed to bridge the knowledge extension gap between agricultural science and farming practice to streamline management decisions. Despite the slow uptake of such support systems in many countries, two studies found that many systems have been successfully adopted (Bramley, 2009; Eastwood et al., 2012).

Several authors agree that formal tools are rarely designed with a detailed understanding of the relationship between farmers' specific knowledge, the decisions they make and the actions they take, and farmers are often not consulted in the design process until release of the final product (Lynch et al., 2000; Öhlmér, 2007; Robert et al., 2016). As a result, early use of new

information management systems is often stressful for farmers accustomed to using an intuitive, experience-based management style, and these systems are subsequently not prioritised (Eastwood et al., 2006). Five studies found that farmers often do not adopt formalised tools as expected, and largely prefer an intuitive approach to an analytic system (Lunneryd, 2003; Öhlmér, 2007; McCown et al., 2012; Kieft, 2015; Nuthall and Old, 2018).

In an example from Sweden, the adoption rate of a computer-based tool aimed at analytic thinking to support farmers' decision making, developed in a research programme spanning three decades, was considerably lower than expected (Öhlmér, 2007). Similarly, in Sweden, the process of gathering information on the strategic decision making by farmers to convert from conventional to organic milk production in Sweden had not been adapted to their specific needs (Lunneryd, 2003). Both Lunneryd (2003) and Öhlmér (2007) found that farmers mostly rely on intuition for decision making.

McCown et al. (2012) found that Australian farmers were initially enthusiastic about adopting analytic decision support system for measuring soil water and managing climatic variability. However, in practice, they used the system to hone their intuitive ability, to which they returned and relied upon heuristically, only using the analytic system in exceptional cases. Similarly, in New Zealand, the most successful (efficient and/or profitable) stock-cattle farmers relied less on formal technological tools designed to aid their practical decision making, and instead developed a personalised expert system, with intuition being the primary driver (Nuthall, 2012). This expert system was a technology-based encapsulation of decision rules used by farmer experts, through a question and answer system based on explicit knowledge. While studying farmers' expert systems was valuable, there was an element of impracticality when basing development of technological tools for grazing management, since farmers preferred to rely on intuition.

Farmers' knowledge is not static, nor are their decisions likely to be made in the same way over time as their experience grows, their knowledge base evolves, and as external environments become more challenging (Eastwood et al., 2012). This means that formal decision support tools would need to be constantly re-evaluated and adapted to efficiently support farmers (Douthwaite et al., 2001; Eastwood et al., 2012).

We have seen that farmer decision making is a complex process involving values, goals, observation, intuition and intention, yet management programmes that do not consider these factors are less likely to be effective (van Eijk, 1998; OECD, 2012). Hochman and Carberry (2011) argue that support systems should allow users to experiment with options that satisfy their needs, and develop intuition instead of replacing it with optimised recommendations.

3.2 The call to focus research attention on the development of farmer intuition

Nuthall and Old (2018) found that successful farm managers made most of their decisions using their well-developed intuitive ability, i.e. they could confidently apply their intuition to make a successful decision. They present an original model to explain intuition, using data from 818 farms in New Zealand and based on influencing variables, including experience, feedback and repetition, training and mentoring, reflection and self-critique, intelligence and personality, objectives and risk attitude, observation and anticipation skills.

Farmers often describe intuition as crucial for farm health management. In a study of farm health among 79 organic farmers in Austria, Germany, and the UK, health was seen as an interconnected system based on close observation and decision-making processes (Paxton et al., 2017). One of ten key factors identified for healthy farming systems was the development

of intuition and the associated ability for self-observation. As one farmer explained: "We're always talking about things that are not actually tangible… this is something older, something that we have lost… intuition should be the first point concerning the importance for health". (Paxton et al, 2017: 83). Other farmers considered that intuition allowed for customised practical decisions (Paxton et al., 2017). Since resilience and health are interdependent (Döring et al., 2013), this suggests that farmers may use intuition to build resilience.

Research has showed that farmers in the Netherlands, Brazil, Peru and Sri Lanka secured considerable benefits by relying largely on intuition (Kieft, 2006, 2015). Surveyed farmers claimed that, while proficiency and experience in practical farming skills were important, their success stemmed mainly from using their intuition to inform and accelerate decisions. They reported earlier disease detection and improved disease resilience, enabling a reduction in chemical inputs and water use, resulting in improved yields and product quality (specifically nutritional value and shelf-life), and higher input efficiency, in both plant and animal production. In dairy farming, benefits such as quieter animals, lower antibiotic use and veterinary costs, higher calf survival rates, improved immune response, and more efficient feed conversion rates were reported. Many of these farmers also benefitted from an improved work-life balance and a deeper sense of satisfaction, as well as minimising environmental impact and working in closer harmony with nature. All the surveyed farmers operated intuitively, and the study concluded that farmer intuition should be accepted, respected, and actively enhanced.

For too long, agricultural research has seen intuition as non-scientific and problematic (van Eijk, 1998). The growing recognition that it deserves more focused attention from researchers and farmers does not imply that farmers should use their analytical skills less, or that research into the analytic decision processes of farmers should discontinue. However, there is a gap in understanding how to support farmers to confidently and consciously use their intuition. Such

support would be especially important for small-scale and subsistence farmers who may not have access to external tools (Boateng, 2006).

Because farmers generally prefer quick and simple vs. detailed and elaborate analysis, and lean towards incremental implementation (Öhlmér et al., 1998), cognitive analysis is favourable when tasks are analytically simple, yet, as analytical complexity increases, intuition becomes more advantageous, being quick and effortless (Hogarth, 2010). This is recognised by some industry advisors, such as the whole farm/ranch planning framework developed by Holistic Management International. Of their seven tests that a holistic management decision should pass, the last and most important is the "gut check", which asks "not what you think, but how you feel about an action or decision" (HMI, 2013).

3.3 Potential challenges of relying on intuition

That intuition is not easily verbalized presents a potential problem for farms with large management structures and teams, as the whole team needs to be aware that this ability is being consciously used (Öhlmér, 2007). Composition of the management team in terms of levels of expertise would impact how intuitive insights are shared in the team, and those with greater managerial responsibility may require a better developed intuitive ability, which needs to reflect in clear roles and responsibilities within the team (Salas et al. 2009).

Khatri and Ng (2000) point out that an intuitive decision-maker may be accused of being overly influenced by emotions. While intuitive decisions are not emotional per se, they can be affected by the subtle priming of emotions (Hogarth, 2010). According to Bolte et al. (2003), a positive mood improves intuitive coherence judgments, whereas the performance level of intuition,

while in a negative mood, can be equal to chance. Kahneman (2003) highlights the importance of managing one's emotional triggers and bias, as also pointed out by (Nuthall and Old, 2018).

Hogarth (2010) suggests that reliance on intuition may be dysfunctional if the environment in which it is used is significantly different to the one in which the intuitive ability was trained, and that people's intuition cannot be trained to handle situations with which they not are familiar. Yet it plays a role in creative decision making in new, dynamic or complex situations, such as is typically experienced in agroecological systems, and novices have strong intuitions that could be fostered (Salas et al., 2009). So, honing intuition in any environment might be a helpful tool for farmers with little or no prior experience, such as young or entrant farmers. Intuition may be fallible, and the true success rate of intuition is unknown (Salas et al., 2009; Hogarth, 2010). However, when used frequently over time and integrating reflective processes, farmers become more adept at trusting their intuition, increasing in confidence and reliability (Sadler-Smith and Shefy, 2007; Lufityanto et al., 2016).

3.4 Developing intuition: the role of personal development and nature connectedness

Based on extensive research, the handbook *The Intuitive Farmer: Inspiring Management Success* (Nuthall, 2016) offers principles and practices for improving intuition for farm management, and is presented in an accessible narrative format. Here, high managerial ability requires excellent technical knowledge in the first instance, but knowing how to apply decision methods that lead to success is critical. 'Informed intuition' requires experiencing appropriate lessons repeatedly, together with reviewing efficient decisions by both oneself and others. Developing confident and informed intuition depends on gaining practical experience, developing observation and anticipation skills, practicing structured reflection and self-

critique, as well as consulting with professionals, friends and family for both personal and professional feedback.

People vary in their intuitive abilities, due to genetics, upbringing and bias, but most humans have the ability to engage in reflexive processes, which are crucial to developing informed intuition (Nuthall and Old, 2018). The importance of personal transformation in developing intuition, which includes learning to manage emotions and bias which might influence intuition, has been emphasized by various authors. The most effective techniques for personal transformation include journaling, meditation (particularly Transcendental Meditation), practicing mindfulness, and developing somatic awareness through tactile experiences and movement skills and routines (van Eijk 1998; Sadler-Smith and Shefy, 2007; Nonaka and van Krogh, 2009; Kieft 2015). The Somatics Toolkit offers a movement-based methodology designed to incorporate, and learn from, the body as a research tool (see http://somaticstoolkit.coventry.ac.uk).

Intriguingly, some biodynamic farmers are more comfortable with speaking about their feelings and the concept of intuition than are other organic farmers (Anja Vieweger, personal observation). Steiner (1967, 1995), founder of biodynamic agriculture, considered intuition the highest stage of non-physical perception, and pivotal to the examining of one's own thoughts in the quest for self-awareness. In agreement with Steiner, prominent western philosophers since the 17th century, including Henri Bergson (Bergson, 1911), Karl Popper (Jarvie et al., 2006) and Baruch de Spinoza (van Eijk, 2019) have described intuition as a method to attain deeper or higher knowledge.

While biodynamic certification for farms only regulates physical practice requirements, the theory behind biodynamics provides systematic guidelines for self-observation and for

developing intuition (von Diest, 2019). Steiner's (1995) '*hineinversetzung*' - placing one's awareness as if through the eyes of other beings and observing what happens inside oneself - is similar to using the entire human constitution to 'sense subtle energies' within the agro-ecological landscape (Kieft, 2006, 2015, 2019).

Interestingly, farmers say they feel better and/or healthier when practising intuitive farming, and feel more connected with their community and nature (Kieft, 2006; Nuthall and Old, 2018). Sadler-Smith and Shefy (2007) suggest that 'the feeling' that an environment induces is important in training intuition, and note other positive outcomes, such as improved self-confidence, inter- and intra-personal sensitivity and metacognition.

Nature connectedness is promising for improvements to farmer health and resilience, and the interrelated health and resilience of agroecosystems of which they are a part (Simaika and Samways, 2018). As individuals have regular experiences of oneness with nature, a gradual and long-lasting shift in attitude towards nature and a more ecological worldview is facilitated, enabling a paradigm shift from a more positivist one in which the farmer/human is a steward of nature, to perhaps a more mystical one in which farmers/humans feel unified with the rest of nature (van Eijk, 1998). This bears in mind that connectedness with nature is a holistic process that goes beyond only obtaining information about nature, and provides motivation and a reliable predictor for environmentally responsible behaviour (Zylstra, 2014). Nature connectedness may thus enable farmers to be aware of, and manage, their emotional triggers, as well as think more creatively, which in turn, would benefit both analytic and intuitive thinking.

4. Appropriate methodologies for future research

Assuming farmers require and/or want research support in developing intuition, research methodologies that embrace farmer intuition would need to be both respectful and inclusive of different ways of knowing, and centralise the need for endogenous knowledge development in a given culture or region (van Eijk, 1998; ETC-COMPAS, 2007; COMPAS/UDS, 2008), such as approaches applied in the integrative scientific discipline and movement of agroecology (Pimbert, 2015). Here, researchers are co-inquirers in a reciprocal relationship with study participants (rather than subjects) (Chilisa, 2012; Curry and Kirwan, 2014; Madjidi, 2014). Of course, intuition on the part of the researcher would provide a latent resource to make key decisions in developing the research process (van Eijk, 1998; Madjidi, 2014; Rosenberg, 2017).

If nature connectedness is involved in, or helps with, refining an intuitive connection for development of regenerative farm practices, there may be benefits in borrowing from fields of study like ecological psychology (informed by deep ecology) (Roszak et al., 1995), multi-species ethnography (Kirksey and Helmreich, 2010), animism (Harding, 2015) and ecofluency (von Diest, 2019). Studies like those of Madjidi (2014), Zylstra (2014) and van Eijk (1998), which use such approaches, provide theories and methodologies for facilitation and support, for both individual and group processes towards personal and collective transformation and evolution.

5. Summary and conclusions

Research shows that challenges to farm management are more complex and site-specific than can be accurately represented by standardised scientific models favoured by mainstream agriculture, and management decisions by analytical methods. Management decisions often require quick and accurate forecasts for complex situations that are seldom formally available. As cognitive analysis takes longer and cannot fully calculate realistic risk, farmers must often rely on intuition. Intuition

allows access to tacit knowledge, which, although not externalised, offers insight into holistic, tailored solutions.

Although not new to farmers, intuition is a relatively new concept in agricultural research. The few existing studies on this topic agree that many farmers have well-developed intuition, resulting in significant benefits, and all agree on the need to focus research on supporting farmers to develop their intuition. This is not to replace, but rather to complement farmers' analytical processes. Importance of managing emotions and personal development are emphasized in the intuition development process, as well as the potential for improved connectedness with nature.

What is needed is not more knowledge, but better knowing. If more farmers were to consciously and confidently leverage the latent, free resource of their intuition, they may be empowered to more easily make ecologically cohesive management decisions tailored to any given situation. This could help re-embed farmers centrally within the agroecosystem, as the necessary step beyond them simply being perceived as recipients of external knowledge and acting as objective managers of farm systems. Focusing research on the emergent field of intuitive farming, offers stimulus for the paradigm shift called for to reinvigorate resilient agriculture.

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A call to focus on farmer intuition for improved management decision making

Abstract

Mainstream agricultural research takes a rational approach to generate, empirical, tangible knowledge for increased yields and sustainability. This approach has led to the development of technological tools to support farmers in their management decision making, which, while helpful, are not able to factor in the complex, dynamic variables that motivate farmer decision making. More importantly, farmers often do not adopt these tools as expected.

Could a solution lie in considering other sources and types of agricultural knowledge? Some farmers report relying largely on intuition (knowing from within) to inform their practical management decisions, resulting in both qualitative and quantitative benefits. Intuition allows access to valuable tacit (informal, intangible) knowledge, which can be used to explore and apply more resilient agricultural practices. It is an immediate and valuable part of decision making, and deserves more attention from both farmers and researchers.

This paper discusses potential advantages, challenges to, and methods of mainstreaming farmer intuition, and presents appropriate methodologies for its development, emphasizing the need to expand the underlying ontology and epistemology of the mainstream scientific community.

Keywords: farmer decision making; farm management; tacit knowledge; holistic decisions; resilient farming systems

1. Introduction

Farmers are increasingly pressured to make management decisions that are both efficient and ecologically robust. However, the reasoning and values behind these decisions are more individualistic than has been appreciated. A review of 55 studies spanning 25 years of literature in the United States was inconclusive as to which factors consistently determined farmers' reasons for adopting best management practices (Prokopy et al., 2008). Furthermore, a synthesis of 31 empirical analyses on farmer adoption of conservation agriculture found few variables that universally explained farmers' motivation to adopt certain practices (Knowler and Bradshaw, 2007). So how do farmers make management decisions, and especially those that consider longer-term ecological and social consequences?

Applied ecological knowledge arises not only from formal scientific study, but also through farmers' experiential learning from interactions with their agroecosystems, leading to context-specific knowledge that draws on local resources rather than more generalised and widely applicable solutions (Altieri, 1995). So, perhaps the key lies in widening the recognition of, access to, and application of different types and forms of knowledge (Curry and Kirwan, 2014; Code, 2018).

2. Different sources of knowledge in agriculture

2.1 Examining the mainstream sources of knowledge in agriculture

The dominant ontology (belief about the nature of reality, or how the world is) and epistemology (belief about the grounds for human knowledge, or how the world can be known) of the mainstream agricultural paradigm is largely positivist, in that all matter and processes can be reduced to concrete matter. It looks to modern (Newtonian-Cartesian) 'Western' science

to provide knowledge, accumulated through observable data gathered in controlled and repeatable experiments (van Eijk, 1998). This results in explicit knowledge, i.e. formal knowledge that can be articulated, documented, codified, and easily transferred in a systematic and tangible form using words, numbers and formulae, and disseminated through, for example, instruction manuals (Boateng, 2006; Nonaka and van Krogh, 2009; Vangala et al., 2014).

The paradigm shift called for in the United Nations Conference on Trade and Development (UNCTAD) Trade and Environment Review (2013) report invites examination of how knowledge that is thought by modern science to be appropriate for sustainable agriculture is generated and used. Going further, van Eijk (1998) and Code (2018) identify the need to question the ontology and epistemology of mainstream agricultural research, and to recognise and include the role of interior knowledge sources.

This has been addressed, to some extent, when agricultural research began to acknowledge the constructivist paradigm (constructed nature of reality) in the 1980s (van Eijk, 1998), including through the exploration of indigenous research methods (Apusigah, 2011; Chilisa, 2012). However, tacit knowledge still has not yet been significantly addressed (van Eijk, 1998; Boateng, 2006; Curry and Kirwan, 2014; Vangala et al., 2014). Tacit knowledge is intangible, personal, often experiential and informal in nature, involving conscious and unconscious awareness of perspective, personal beliefs, values and innate knowing. It is found in traditions, customs and *savoire-faire* (adaptive ability to determine appropriate action). It can refer to the decision rules stored in the mind, but is implicit in nature and cannot always be articulated, codified, or transferred. Yet it can be accessed through intuitive processes (Boateng, 2006; Nonaka and van Krogh, 2009).

2.2. Value of using intuition in decision making

Dane and Pratt (2007) define intuition as 'affectively-charged judgements that arise through rapid, non-conscious, and holistic associations', or 'the provision of a conclusion reached without formal analysis'. Perhaps a simpler and more apt definition of intuition is 'knowing without knowing how you know', or 'knowing from within' (Hodgkinson et al., 2008). To date, most evidence on the value of intuition comes from the fields of psychology and business management, and is recognised as critical in hyper-competitive business environments (Harvey et al., 2002) and clinical judgement in medicine (Chin-Yee and Fuller, 2018).

In the field of economics, Kahneman (2003) observes that decision makers are aware of limited information, and most judgements and decisions are made intuitively. He presents a map of 'cognition architecture', in which the characteristics of intuitive and reasoning (rational/logical) systems are summarised. Here, intuition resembles perception, and both are fast, automatic, associative, and reference-dependent, or stimulus-bound. Reasoning, by contrast, is slow, controlled, and neutral, and both intuition and reason are informed by experience. He emphasises that intuition can be powerful and accurate, but applying it effectively requires prolonged practice. Given our perspective on the constructivist, subjective nature of reality, we would contend Kahneman's (2003) identification of reasoning as being neutral.

Overall, intuition appears to be an involuntary, immediate and inevitable part of all decisions, which can complement logical cognition, and can be highly useful when there is a time constraint on gathering (potentially unreliable) information (Khatri and Ng, 2000). It can boost accuracy, confidence, and speed in the decision-making process (Lufityanto et al., 2016). This suggests that applying intuition, and thus accessing tacit forms of knowledge, holds potential for improved farm management decision making

2.3 Learning from traditional and indigenous ecological knowledge systems

Many traditional and indigenous cultures worldwide have evolved a highly integrated, holistic, intuitive understanding of the complex natural systems in which they live, and maintaining a dialogue with these systems is crucial for managing food production landscapes (Parry, 2005; Apusigah, 2011). Small-scale and subsistence farmers use their tacit understanding to adapt to increasingly unpredictable climatic conditions, such as drought, thereby increasing the resilience of their agroecosystems (Kieft, 2006, 2015; IAASTD 2009; Makondo and Thomas, 2018). Resilience (the ability to remain functional under stress) is an important criterion of health and adaptability in agricultural systems (Döring et al., 2013), and is crucial for farmers to consider in their decision making, especially in regions with rapidly-changing climatic conditions.

This 'situational knowledge' (Haraway 1988) is generated through experience, language, culture and tradition *in situ*, and through more than the five physical senses. These stocks of intuition, or cultural capital (Hogarth, 2010), are the product of tacit learning, and expand on, and contribute to, a more holistic, pragmatic knowledge base than the (explicit) knowledge gained through modern science's overemphasis on the sense of vision and observation.

Several global organisations have called for the protection and utilization of these knowledge systems, arising from their value in evolving adaptive agricultural solutions and addressing global food security. For example, in 2002, the Food and Agriculture Organization initiated the Globally Important Agricultural Heritage Systems (GIAHS) programme, to safeguard and support indigenous and traditional knowledge systems at risk of disappearing through the spread of industrialised agriculture. GIAHS policy suggestions are already being applied, as in the case of the inter-university initiative Capacity and Theory Building of Universities and Research Centres

on Endogenous Development (CAPTURED), which has formulated curricula to include ancient wisdom and intuitive knowing into higher education (Haverkort, 2010).

2.4 Potential risk of externalising tacit knowledge

Organization science places both explicit and tacit knowledge along a continuum, and considers that the less extreme forms of tacit knowledge may be externalized or converted (Nonaka and van Krogh, 2009), to allow for the expansion of knowledge beyond what exists in one individual or community. Through participatory research approaches, some tacit knowledge embedded in traditional and indigenous ecological knowledge systems has been externalised for improving and developing sustainable agricultural practices (Eastwood et al., 2012; Curry and Kirwan, 2014). Steps such as the GIAHS programme contribute greatly to understanding and using the various knowledge bases of farmers worldwide. However, apart from the innate difficulty in expressing tacit knowledge, building mutual trust for an effective 'dialogue of wisdom' with those holding tacit knowledge is not easy. Knowledge holders may be reluctant to share with western scientists, expressing a lack of confidence in its appropriate use outside of their own cultural and spiritual context. For example, knowledge about local plants shared with researchers of international seed businesses has often been exploited for profit (Henk Kieft, personal observation).

Additionally, because such embedded knowledge is situational, practices developed from them are appropriate to local cultures and regional conditions, and not well suited to adapting to, or scaling up within, other cultures and regions (Chilisa, 2012). And because of the internal, experiential nature of both intuition and tacit knowledge, an externalisation process could alter or dilute the value of such knowledge (Hodgkinson et al., 2008).

This location-specificity is at odds with the positivist paradigm of mainstream agriculture. Could support for farmers to individually access and apply tacit knowledge circumvent this? Certainly, farmers would be imbued with more agency and autonomy than is currently the case.

3. Reviewing the role of intuition in farmer decision making

To assess how existing agricultural research addresses intuition in farmer decision making, we performed a search on the scientific databases Scopus and Web of Science, cross-referencing the keywords 'intuition' with 'agriculture' and 'farming'. Filtering 60 search results for relevance to management decision making yielded a total of seven papers, all published in the 16 years up until 2019. We included a further two articles from conference proceedings.

3.1 The need to reconsider the analytic approach to supporting farmer decision making

Five of the seven articles from our initial search were associated with the development and use of analytical decision support systems in industrialised countries. Using a rational/logical approach based on cognitive task analysis, formal tools using information communication technologies have been developed to bridge the knowledge extension gap between agricultural science and farming practice to streamline management decisions. Despite the slow uptake of such support systems in many countries, two studies found that many systems have been successfully adopted (Bramley, 2009; Eastwood et al., 2012).

Several authors agree that formal tools are rarely designed with a detailed understanding of the relationship between farmers' specific knowledge, the decisions they make and the actions they take, and farmers are often not consulted in the design process until release of the final product (Lynch et al., 2000; Öhlmér, 2007; Robert et al., 2016). As a result, early use of new

information management systems is often stressful for farmers accustomed to using an intuitive, experience-based management style, and these systems are subsequently not prioritised (Eastwood et al., 2006). Five studies found that farmers often do not adopt formalised tools as expected, and largely prefer an intuitive approach to an analytic system (Lunneryd, 2003; Öhlmér, 2007; McCown et al., 2012; Kieft, 2015; Nuthall and Old, 2018).

In an example from Sweden, the adoption rate of a computer-based tool aimed at analytic thinking to support farmers' decision making, developed in a research programme spanning three decades, was considerably lower than expected (Öhlmér, 2007). Similarly, in Sweden, the process of gathering information on the strategic decision making by farmers to convert from conventional to organic milk production in Sweden had not been adapted to their specific needs (Lunneryd, 2003). Both Lunneryd (2003) and Öhlmér (2007) found that farmers mostly rely on intuition for decision making.

McCown et al. (2012) found that Australian farmers were initially enthusiastic about adopting analytic decision support system for measuring soil water and managing climatic variability. However, in practice, they used the system to hone their intuitive ability, to which they returned and relied upon heuristically, only using the analytic system in exceptional cases. Similarly, in New Zealand, the most successful (efficient and/or profitable) stock-cattle farmers relied less on formal technological tools designed to aid their practical decision making, and instead developed a personalised expert system, with intuition being the primary driver (Nuthall, 2012). This expert system was a technology-based encapsulation of decision rules used by farmer experts, through a question and answer system based on explicit knowledge. While studying farmers' expert systems was valuable, there was an element of impracticality when basing development of technological tools for grazing management, since farmers preferred to rely on intuition.

Farmers' knowledge is not static, nor are their decisions likely to be made in the same way over time as their experience grows, their knowledge base evolves, and as external environments become more challenging (Eastwood et al., 2012). This means that formal decision support tools would need to be constantly re-evaluated and adapted to efficiently support farmers (Douthwaite et al., 2001; Eastwood et al., 2012).

We have seen that farmer decision making is a complex process involving values, goals, observation, intuition and intention, yet management programmes that do not consider these factors are less likely to be effective (van Eijk, 1998; OECD, 2012). Hochman and Carberry (2011) argue that support systems should allow users to experiment with options that satisfy their needs, and develop intuition instead of replacing it with optimised recommendations.

3.2 The call to focus research attention on the development of farmer intuition

Nuthall and Old (2018) found that successful farm managers made most of their decisions using their well-developed intuitive ability, i.e. they could confidently apply their intuition to make a successful decision. They present an original model to explain intuition, using data from 818 farms in New Zealand and based on influencing variables, including experience, feedback and repetition, training and mentoring, reflection and self-critique, intelligence and personality, objectives and risk attitude, observation and anticipation skills.

Farmers often describe intuition as crucial for farm health management. In a study of farm health among 79 organic farmers in Austria, Germany, and the UK, health was seen as an interconnected system based on close observation and decision-making processes (Paxton et al., 2017). One of ten key factors identified for healthy farming systems was the development

of intuition and the associated ability for self-observation. As one farmer explained: "We're always talking about things that are not actually tangible… this is something older, something that we have lost… intuition should be the first point concerning the importance for health". (Paxton et al, 2017: 83). Other farmers considered that intuition allowed for customised practical decisions (Paxton et al., 2017). Since resilience and health are interdependent (Döring et al., 2013), this suggests that farmers may use intuition to build resilience.

Research has showed that farmers in the Netherlands, Brazil, Peru and Sri Lanka secured considerable benefits by relying largely on intuition (Kieft, 2006, 2015). Surveyed farmers claimed that, while proficiency and experience in practical farming skills were important, their success stemmed mainly from using their intuition to inform and accelerate decisions. They reported earlier disease detection and improved disease resilience, enabling a reduction in chemical inputs and water use, resulting in improved yields and product quality (specifically nutritional value and shelf-life), and higher input efficiency, in both plant and animal production. In dairy farming, benefits such as quieter animals, lower antibiotic use and veterinary costs, higher calf survival rates, improved immune response, and more efficient feed conversion rates were reported. Many of these farmers also benefitted from an improved work-life balance and a deeper sense of satisfaction, as well as minimising environmental impact and working in closer harmony with nature. All the surveyed farmers operated intuitively, and the study concluded that farmer intuition should be accepted, respected, and actively enhanced.

For too long, agricultural research has seen intuition as non-scientific and problematic (van Eijk, 1998). The growing recognition that it deserves more focused attention from researchers and farmers does not imply that farmers should use their analytical skills less, or that research into the analytic decision processes of farmers should discontinue. However, there is a gap in understanding how to support farmers to confidently and consciously use their intuition. Such

support would be especially important for small-scale and subsistence farmers who may not have access to external tools (Boateng, 2006).

Because farmers generally prefer quick and simple vs. detailed and elaborate analysis, and lean towards incremental implementation (Öhlmér et al., 1998), cognitive analysis is favourable when tasks are analytically simple, yet, as analytical complexity increases, intuition becomes more advantageous, being quick and effortless (Hogarth, 2010). This is recognised by some industry advisors, such as the whole farm/ranch planning framework developed by Holistic Management International. Of their seven tests that a holistic management decision should pass, the last and most important is the "gut check", which asks "not what you think, but how you feel about an action or decision" (HMI, 2013).

3.3 Potential challenges of relying on intuition

That intuition is not easily verbalized presents a potential problem for farms with large management structures and teams, as the whole team needs to be aware that this ability is being consciously used (Öhlmér, 2007). Composition of the management team in terms of levels of expertise would impact how intuitive insights are shared in the team, and those with greater managerial responsibility may require a better developed intuitive ability, which needs to reflect in clear roles and responsibilities within the team (Salas et al. 2009).

Khatri and Ng (2000) point out that an intuitive decision-maker may be accused of being overly influenced by emotions. While intuitive decisions are not emotional per se, they can be affected by the subtle priming of emotions (Hogarth, 2010). According to Bolte et al. (2003), a positive mood improves intuitive coherence judgments, whereas the performance level of intuition,

while in a negative mood, can be equal to chance. Kahneman (2003) highlights the importance of managing one's emotional triggers and bias, as also pointed out by (Nuthall and Old, 2018).

Hogarth (2010) suggests that reliance on intuition may be dysfunctional if the environment in which it is used is significantly different to the one in which the intuitive ability was trained, and that people's intuition cannot be trained to handle situations with which they not are familiar. Yet it plays a role in creative decision making in new, dynamic or complex situations, such as is typically experienced in agroecological systems, and novices have strong intuitions that could be fostered (Salas et al., 2009). So, honing intuition in any environment might be a helpful tool for farmers with little or no prior experience, such as young or entrant farmers. Intuition may be fallible, and the true success rate of intuition is unknown (Salas et al., 2009; Hogarth, 2010). However, when used frequently over time and integrating reflective processes, farmers become more adept at trusting their intuition, increasing in confidence and reliability (Sadler-Smith and Shefy, 2007; Lufityanto et al., 2016).

3.4 Developing intuition: the role of personal development and nature connectedness

Based on extensive research, the handbook *The Intuitive Farmer: Inspiring Management Success* (Nuthall, 2016) offers principles and practices for improving intuition for farm management, and is presented in an accessible narrative format. Here, high managerial ability requires excellent technical knowledge in the first instance, but knowing how to apply decision methods that lead to success is critical. 'Informed intuition' requires experiencing appropriate lessons repeatedly, together with reviewing efficient decisions by both oneself and others. Developing confident and informed intuition depends on gaining practical experience, developing observation and anticipation skills, practicing structured reflection and self-

critique, as well as consulting with professionals, friends and family for both personal and professional feedback.

People vary in their intuitive abilities, due to genetics, upbringing and bias, but most humans have the ability to engage in reflexive processes, which are crucial to developing informed intuition (Nuthall and Old, 2018). The importance of personal transformation in developing intuition, which includes learning to manage emotions and bias which might influence intuition, has been emphasized by various authors. The most effective techniques for personal transformation include journaling, meditation (particularly Transcendental Meditation), practicing mindfulness, and developing somatic awareness through tactile experiences and movement skills and routines (van Eijk 1998; Sadler-Smith and Shefy, 2007; Nonaka and van Krogh, 2009; Kieft 2015). The Somatics Toolkit offers a movement-based methodology designed to incorporate, and learn from, the body as a research tool (see http://somaticstoolkit.coventry.ac.uk).

Intriguingly, some biodynamic farmers are more comfortable with speaking about their feelings and the concept of intuition than are other organic farmers (Anja Vieweger, personal observation). Steiner (1967, 1995), founder of biodynamic agriculture, considered intuition the highest stage of non-physical perception, and pivotal to the examining of one's own thoughts in the quest for self-awareness. In agreement with Steiner, prominent western philosophers since the 17th century, including Henri Bergson (Bergson, 1911), Karl Popper (Jarvie et al., 2006) and Baruch de Spinoza (van Eijk, 2019) have described intuition as a method to attain deeper or higher knowledge.

While biodynamic certification for farms only regulates physical practice requirements, the theory behind biodynamics provides systematic guidelines for self-observation and for

developing intuition (von Diest, 2019). Steiner's (1995) '*hineinversetzung*' - placing one's awareness as if through the eyes of other beings and observing what happens inside oneself - is similar to using the entire human constitution to 'sense subtle energies' within the agro-ecological landscape (Kieft, 2006, 2015, 2019).

Interestingly, farmers say they feel better and/or healthier when practising intuitive farming, and feel more connected with their community and nature (Kieft, 2006; Nuthall and Old, 2018). Sadler-Smith and Shefy (2007) suggest that 'the feeling' that an environment induces is important in training intuition, and note other positive outcomes, such as improved self-confidence, inter- and intra-personal sensitivity and metacognition.

Nature connectedness is promising for improvements to farmer health and resilience, and the interrelated health and resilience of agroecosystems of which they are a part (Simaika and Samways, 2018). As individuals have regular experiences of oneness with nature, a gradual and long-lasting shift in attitude towards nature and a more ecological worldview is facilitated, enabling a paradigm shift from a more positivist one in which the farmer/human is a steward of nature, to perhaps a more mystical one in which farmers/humans feel unified with the rest of nature (van Eijk, 1998). This bears in mind that connectedness with nature is a holistic process that goes beyond only obtaining information about nature, and provides motivation and a reliable predictor for environmentally responsible behaviour (Zylstra, 2014). Nature connectedness may thus enable farmers to be aware of, and manage, their emotional triggers, as well as think more creatively, which in turn, would benefit both analytic and intuitive thinking.

4. Appropriate methodologies for future research

Assuming farmers require and/or want research support in developing intuition, research methodologies that embrace farmer intuition would need to be both respectful and inclusive of different ways of knowing, and centralise the need for endogenous knowledge development in a given culture or region (van Eijk, 1998; ETC-COMPAS, 2007; COMPAS/UDS, 2008), such as approaches applied in the integrative scientific discipline and movement of agroecology (Pimbert, 2015). Here, researchers are co-inquirers in a reciprocal relationship with study participants (rather than subjects) (Chilisa, 2012; Curry and Kirwan, 2014; Madjidi, 2014). Of course, intuition on the part of the researcher would provide a latent resource to make key decisions in developing the research process (van Eijk, 1998; Madjidi, 2014; Rosenberg, 2017).

If nature connectedness is involved in, or helps with, refining an intuitive connection for development of regenerative farm practices, there may be benefits in borrowing from fields of study like ecological psychology (informed by deep ecology) (Roszak et al., 1995), multi-species ethnography (Kirksey and Helmreich, 2010), animism (Harding, 2015) and ecofluency (von Diest, 2019). Studies like those of Madjidi (2014), Zylstra (2014) and van Eijk (1998), which use such approaches, provide theories and methodologies for facilitation and support, for both individual and group processes towards personal and collective transformation and evolution.

5. Summary and conclusions

Research shows that challenges to farm management are more complex and site-specific than can be accurately represented by standardised scientific models favoured by mainstream agriculture, and management decisions by analytical methods. Management decisions often require quick and accurate forecasts for complex situations that are seldom formally available. As cognitive analysis takes longer and cannot fully calculate realistic risk, farmers must often rely on intuition. Intuition

allows access to tacit knowledge, which, although not externalised, offers insight into holistic, tailored solutions.

Although not new to farmers, intuition is a relatively new concept in agricultural research. The few existing studies on this topic agree that many farmers have well-developed intuition, resulting in significant benefits, and all agree on the need to focus research on supporting farmers to develop their intuition. This is not to replace, but rather to complement farmers' analytical processes. Importance of managing emotions and personal development are emphasized in the intuition development process, as well as the potential for improved connectedness with nature.

What is needed is not more knowledge, but better knowing. If more farmers were to consciously and confidently leverage the latent, free resource of their intuition, they may be empowered to more easily make ecologically cohesive management decisions tailored to any given situation. This could help re-embed farmers centrally within the agroecosystem, as the necessary step beyond them simply being perceived as recipients of external knowledge and acting as objective managers of farm systems. Focusing research on the emergent field of intuitive farming, offers stimulus for the paradigm shift called for to reinvigorate resilient agriculture.

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