

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

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

4 Abstract

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

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

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

21 **Keywords:** farmer decision making; farm management; tacit knowledge; holistic decisions;
22 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

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3 53 to provide knowledge, accumulated through observable data gathered in controlled and
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5 54 repeatable experiments (van Eijk, 1998). This results in explicit knowledge, i.e. formal
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7 55 knowledge that can be articulated, documented, codified, and easily transferred in a systematic
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9 56 and tangible form using words, numbers and formulae, and disseminated through, for example,
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11 57 instruction manuals (Boateng, 2006; Nonaka and van Krogh, 2009; Vangala et al., 2014).
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16 59 The paradigm shift called for in the United Nations Conference on Trade and Development
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18 60 (UNCTAD) Trade and Environment Review (2013) report invites examination of how
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20 61 knowledge that is thought by modern science to be appropriate for sustainable agriculture is
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22 62 generated and used. Going further, van Eijk (1998) and Code (2018) identify the need to
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24 63 question the ontology and epistemology of mainstream agricultural research, and to recognise
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26 64 and include the role of interior knowledge sources.
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32 66 This has been addressed, to some extent, when agricultural research began to acknowledge the
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34 67 constructivist paradigm (constructed nature of reality) in the 1980s (van Eijk, 1998), including
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36 68 through the exploration of indigenous research methods (Apusigah, 2011; Chilisa, 2012).
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38 69 However, tacit knowledge still has not yet been significantly addressed (van Eijk, 1998; Boateng,
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40 70 2006; Curry and Kirwan, 2014; Vangala et al., 2014). Tacit knowledge is intangible, personal,
41
42 71 often experiential and informal in nature, involving conscious and unconscious awareness of
43
44 72 perspective, personal beliefs, values and innate knowing. It is found in traditions, customs and
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46 73 *savoir-faire* (adaptive ability to determine appropriate action). It can refer to the decision rules
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48 74 stored in the mind, but is implicit in nature and cannot always be articulated, codified, or
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50 75 transferred. Yet it can be accessed through intuitive processes (Boateng, 2006; Nonaka and van
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52 76 Krogh, 2009).
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60 78 *2.2. Value of using intuition in decision making*

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5 80 Dane and Pratt (2007) define intuition as ‘affectively-charged judgements that arise through
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7 81 rapid, non-conscious, and holistic associations’, or ‘the provision of a conclusion reached
8
9 82 without formal analysis’. Perhaps a simpler and more apt definition of intuition is ‘knowing
10
11 83 without knowing how you know’, or ‘knowing from within’ (Hodgkinson et al., 2008). To date,
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13
14 84 most evidence on the value of intuition comes from the fields of psychology and business
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16 85 management, and is recognised as critical in hyper-competitive business environments (Harvey
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18 86 et al., 2002) and clinical judgement in medicine (Chin-Yee and Fuller, 2018).

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23 88 In the field of economics, Kahneman (2003) observes that decision makers are aware of limited
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25 89 information, and most judgements and decisions are made intuitively. He presents a map of
26
27 90 ‘cognition architecture’, in which the characteristics of intuitive and reasoning (rational/logical)
28
29 91 systems are summarised. Here, intuition resembles perception, and both are fast, automatic,
30
31 92 associative, and reference-dependent, or stimulus-bound. Reasoning, by contrast, is slow,
32
33 93 controlled, and neutral, and both intuition and reason are informed by experience. He emphasises
34
35 94 that intuition can be powerful and accurate, but applying it effectively requires prolonged practice.
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37 95 Given our perspective on the constructivist, subjective nature of reality, we would contend
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39 96 Kahneman’s (2003) identification of reasoning as being neutral.

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45 98 Overall, intuition appears to be an involuntary, immediate and inevitable part of all decisions,
46
47 99 which can complement logical cognition, and can be highly useful when there is a time constraint
48
49 100 on gathering (potentially unreliable) information (Khatri and Ng, 2000). It can boost accuracy,
50
51 101 confidence, and speed in the decision-making process (Lufityanto et al., 2016). This suggests that
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53 102 applying intuition, and thus accessing tacit forms of knowledge, holds potential for improved farm
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55 103 management decision making

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3 105 *2.3 Learning from traditional and indigenous ecological knowledge systems*
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7 107 Many traditional and indigenous cultures worldwide have evolved a highly integrated, holistic,
8
9 108 intuitive understanding of the complex natural systems in which they live, and maintaining a
10
11 109 dialogue with these systems is crucial for managing food production landscapes (Parry, 2005;
12
13 110 Apusigah, 2011). Small-scale and subsistence farmers use their tacit understanding to adapt to
14
15 111 increasingly unpredictable climatic conditions, such as drought, thereby increasing the
16
17 112 resilience of their agroecosystems (Kieft, 2006, 2015; IAASTD 2009; Makondo and Thomas,
18
19 113 2018). Resilience (the ability to remain functional under stress) is an important criterion of
20
21 114 health and adaptability in agricultural systems (Döring et al., 2013), and is crucial for farmers
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23 115 to consider in their decision making, especially in regions with rapidly-changing climatic
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25 116 conditions.
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30 117 This ‘situational knowledge’ (Haraway 1988) is generated through experience, language,
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32 118 culture and tradition *in situ*, and through more than the five physical senses. These stocks of
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34 119 intuition, or cultural capital (Hogarth, 2010), are the product of tacit learning, and expand on,
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36 120 and contribute to, a more holistic, pragmatic knowledge base than the (explicit) knowledge
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38 121 gained through modern science’s overemphasis on the sense of vision and observation.
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44 123 Several global organisations have called for the protection and utilization of these knowledge
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46 124 systems, arising from their value in evolving adaptive agricultural solutions and addressing global
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48 125 food security. For example, in 2002, the Food and Agriculture Organization initiated the Globally
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50 126 Important Agricultural Heritage Systems (GIAHS) programme, to safeguard and support
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52 127 indigenous and traditional knowledge systems at risk of disappearing through the spread of
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54 128 industrialised agriculture. GIAHS policy suggestions are already being applied, as in the case of
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56 129 the inter-university initiative Capacity and Theory Building of Universities and Research Centres
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3 130 on Endogenous Development (CAPTURED), which has formulated curricula to include ancient
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5 131 wisdom and intuitive knowing into higher education (Haverkort, 2010).
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9 133 *2.4 Potential risk of externalising tacit knowledge*

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14 135 Organization science places both explicit and tacit knowledge along a continuum, and considers
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16 136 that the less extreme forms of tacit knowledge may be externalized or converted (Nonaka and van
17
18 137 Krogh, 2009), to allow for the expansion of knowledge beyond what exists in one individual or
19
20 138 community. Through participatory research approaches, some tacit knowledge embedded in
21
22 139 traditional and indigenous ecological knowledge systems has been externalised for improving and
23
24 140 developing sustainable agricultural practices (Eastwood et al., 2012; Curry and Kirwan, 2014).
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28 141 Steps such as the GIAHS programme contribute greatly to understanding and using the various
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30 142 knowledge bases of farmers worldwide. However, apart from the innate difficulty in expressing
31
32 143 tacit knowledge, building mutual trust for an effective ‘dialogue of wisdom’ with those holding
33
34 144 tacit knowledge is not easy. Knowledge holders may be reluctant to share with western scientists,
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36 145 expressing a lack of confidence in its appropriate use outside of their own cultural and spiritual
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38 146 context. For example, knowledge about local plants shared with researchers of international seed
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40 147 businesses has often been exploited for profit (Henk Kieft, personal observation).
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46 149 Additionally, because such embedded knowledge is situational, practices developed from them
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48 150 are appropriate to local cultures and regional conditions, and not well suited to adapting to, or
49
50 151 scaling up within, other cultures and regions (Chilisa, 2012). And because of the internal,
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52 152 experiential nature of both intuition and tacit knowledge, an externalisation process could alter or
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54 153 dilute the value of such knowledge (Hodgkinson et al., 2008).
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3 155 This location-specificity is at odds with the positivist paradigm of mainstream agriculture. Could
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5 156 support for farmers to individually access and apply tacit knowledge circumvent this? Certainly,
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7 157 farmers would be imbued with more agency and autonomy than is currently the case.
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11 159 **3. Reviewing the role of intuition in farmer decision making**

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16 161 To assess how existing agricultural research addresses intuition in farmer decision making, we
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18 162 performed a search on the scientific databases Scopus and Web of Science, cross-referencing
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20 163 the keywords ‘intuition’ with ‘agriculture’ and ‘farming’. Filtering 60 search results for
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22 164 relevance to management decision making yielded a total of seven papers, all published in the
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24 165 16 years up until 2019. We included a further two articles from conference proceedings.
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29 167 *3.1 The need to reconsider the analytic approach to supporting farmer decision making*

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34 169 Five of the seven articles from our initial search were associated with the development and use
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36 170 of analytical decision support systems in industrialised countries. Using a rational/logical
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38 171 approach based on cognitive task analysis, formal tools using information communication
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40 172 technologies have been developed to bridge the knowledge extension gap between agricultural
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42 173 science and farming practice to streamline management decisions. Despite the slow uptake of
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44 174 such support systems in many countries, two studies found that many systems have been
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46 175 successfully adopted (Bramley, 2009; Eastwood et al., 2012).
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53 177 Several authors agree that formal tools are rarely designed with a detailed understanding of the
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55 178 relationship between farmers’ specific knowledge, the decisions they make and the actions they
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57 179 take, and farmers are often not consulted in the design process until release of the final product
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59 180 (Lynch et al., 2000; Öhlmér, 2007; Robert et al., 2016). As a result, early use of new

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3 181 information management systems is often stressful for farmers accustomed to using an
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5 182 intuitive, experience-based management style, and these systems are subsequently not
6
7 183 prioritised (Eastwood et al., 2006). Five studies found that farmers often do not adopt
8
9 184 formalised tools as expected, and largely prefer an intuitive approach to an analytic system
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11 185 (Lunneryd, 2003; Öhlmér, 2007; McCown et al., 2012; Kieft, 2015; Nuthall and Old, 2018).

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16 187 In an example from Sweden, the adoption rate of a computer-based tool aimed at analytic
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18 188 thinking to support farmers' decision making, developed in a research programme spanning
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20 189 three decades, was considerably lower than expected (Öhlmér, 2007). Similarly, in Sweden,
21
22 190 the process of gathering information on the strategic decision making by farmers to convert
23
24 191 from conventional to organic milk production in Sweden had not been adapted to their specific
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26 192 needs (Lunneryd, 2003). Both Lunneryd (2003) and Öhlmér (2007) found that farmers mostly
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28 193 rely on intuition for decision making.

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34 195 McCown et al. (2012) found that Australian farmers were initially enthusiastic about adopting
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36 196 analytic decision support system for measuring soil water and managing climatic variability.
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38 197 However, in practice, they used the system to hone their intuitive ability, to which they returned
39
40 198 and relied upon heuristically, only using the analytic system in exceptional cases. Similarly, in
41
42 199 New Zealand, the most successful (efficient and/or profitable) stock-cattle farmers relied less
43
44 200 on formal technological tools designed to aid their practical decision making, and instead
45
46 201 developed a personalised expert system, with intuition being the primary driver (Nuthall,
47
48 202 2012). This expert system was a technology-based encapsulation of decision rules used by
49
50 203 farmer experts, through a question and answer system based on explicit knowledge. While
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52 204 studying farmers' expert systems was valuable, there was an element of impracticality when
53
54 205 basing development of technological tools for grazing management, since farmers preferred to
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56 206 rely on intuition.

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5 208 Farmers' knowledge is not static, nor are their decisions likely to be made in the same way over
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7 209 time as their experience grows, their knowledge base evolves, and as external environments
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9 210 become more challenging (Eastwood et al., 2012). This means that formal decision support tools
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11 211 would need to be constantly re-evaluated and adapted to efficiently support farmers (Douthwaite
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14 212 et al., 2001; Eastwood et al., 2012).

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18 214 We have seen that farmer decision making is a complex process involving values, goals,
19
20 215 observation, intuition and intention, yet management programmes that do not consider these
21
22 216 factors are less likely to be effective (van Eijk, 1998; OECD, 2012). Hochman and Carberry
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24 217 (2011) argue that support systems should allow users to experiment with options that satisfy their
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26 218 needs, and develop intuition instead of replacing it with optimised recommendations.
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31 32 220 *3.2 The call to focus research attention on the development of farmer intuition*

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36 222 Nuthall and Old (2018) found that successful farm managers made most of their decisions using
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38 223 their well-developed intuitive ability, i.e. they could confidently apply their intuition to make
39
40 224 a successful decision. They present an original model to explain intuition, using data from 818
41
42 225 farms in New Zealand and based on influencing variables, including experience, feedback and
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44 226 repetition, training and mentoring, reflection and self-critique, intelligence and personality,
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46 227 objectives and risk attitude, observation and anticipation skills.
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53 229 Farmers often describe intuition as crucial for farm health management. In a study of farm
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55 230 health among 79 organic farmers in Austria, Germany, and the UK, health was seen as an
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57 231 interconnected system based on close observation and decision-making processes (Paxton et
58
59 232 al., 2017). One of ten key factors identified for healthy farming systems was the development

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3 233 of intuition and the associated ability for self-observation. As one farmer explained: “We’re
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5 234 always talking about things that are not actually tangible... this is something older, something
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7 235 that we have lost... intuition should be the first point concerning the importance for health”.
8
9 236 (Paxton et al, 2017: 83). Other farmers considered that intuition allowed for customised
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11 237 practical decisions (Paxton et al., 2017). Since resilience and health are interdependent (Döring
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14 238 et al., 2013), this suggests that farmers may use intuition to build resilience.

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18 240 Research has showed that farmers in the Netherlands, Brazil, Peru and Sri Lanka secured
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21 241 considerable benefits by relying largely on intuition (Kieft, 2006, 2015). Surveyed farmers
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23 242 claimed that, while proficiency and experience in practical farming skills were important, their
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25 243 success stemmed mainly from using their intuition to inform and accelerate decisions. They
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28 244 reported earlier disease detection and improved disease resilience, enabling a reduction in
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30 245 chemical inputs and water use, resulting in improved yields and product quality (specifically
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32 246 nutritional value and shelf-life), and higher input efficiency, in both plant and animal
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34 247 production. In dairy farming, benefits such as quieter animals, lower antibiotic use and
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37 248 veterinary costs, higher calf survival rates, improved immune response, and more efficient feed
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39 249 conversion rates were reported. Many of these farmers also benefitted from an improved work-
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41 250 life balance and a deeper sense of satisfaction, as well as minimising environmental impact and
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44 251 working in closer harmony with nature. All the surveyed farmers operated intuitively, and the
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46 252 study concluded that farmer intuition should be accepted, respected, and actively enhanced.

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50 254 For too long, agricultural research has seen intuition as non-scientific and problematic (van
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53 255 Eijk, 1998). The growing recognition that it deserves more focused attention from researchers
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55 256 and farmers does not imply that farmers should use their analytical skills less, or that research
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58 257 into the analytic decision processes of farmers should discontinue. However, there is a gap in
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60 258 understanding how to support farmers to confidently and consciously use their intuition. Such

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

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

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271 *3.3 Potential challenges of relying on intuition*

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

279

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

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3 284 while in a negative mood, can be equal to chance. Kahneman (2003) highlights the importance
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5 285 of managing one's emotional triggers and bias, as also pointed out by (Nuthall and Old, 2018).
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9 287 Hogarth (2010) suggests that reliance on intuition may be dysfunctional if the environment in
10
11 288 which it is used is significantly different to the one in which the intuitive ability was trained,
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14 289 and that people's intuition cannot be trained to handle situations with which they not are
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16 290 familiar. Yet it plays a role in creative decision making in new, dynamic or complex situations,
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18 291 such as is typically experienced in agroecological systems, and novices have strong intuitions
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21 292 that could be fostered (Salas et al., 2009). So, honing intuition in any environment might be a
22
23 293 helpful tool for farmers with little or no prior experience, such as young or entrant farmers.
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25 294 Intuition may be fallible, and the true success rate of intuition is unknown (Salas et al., 2009;
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28 295 Hogarth, 2010). However, when used frequently over time and integrating reflective processes,
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30 296 farmers become more adept at trusting their intuition, increasing in confidence and reliability
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32 297 (Sadler-Smith and Shefy, 2007; Lufityanto et al., 2016).
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37 299 *3.4 Developing intuition: the role of personal development and nature connectedness*

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41 301 Based on extensive research, the handbook *The Intuitive Farmer: Inspiring Management*
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43 302 *Success* (Nuthall, 2016) offers principles and practices for improving intuition for farm
44
45 303 management, and is presented in an accessible narrative format. Here, high managerial ability
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47 304 requires excellent technical knowledge in the first instance, but knowing how to apply decision
48
49 305 methods that lead to success is critical. 'Informed intuition' requires experiencing appropriate
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51 306 lessons repeatedly, together with reviewing efficient decisions by both oneself and others.
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53 307 Developing confident and informed intuition depends on gaining practical experience,
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55 308 developing observation and anticipation skills, practicing structured reflection and self-
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3 309 critique, as well as consulting with professionals, friends and family for both personal and
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5 310 professional feedback.

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9 312 People vary in their intuitive abilities, due to genetics, upbringing and bias, but most humans
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11 313 have the ability to engage in reflexive processes, which are crucial to developing informed
12
13 314 intuition (Nuthall and Old, 2018). The importance of personal transformation in developing
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15 315 intuition, which includes learning to manage emotions and bias which might influence
16
17 316 intuition, has been emphasized by various authors. The most effective techniques for personal
18
19 317 transformation include journaling, meditation (particularly Transcendental Meditation),
20
21 318 practicing mindfulness, and developing somatic awareness through tactile experiences and
22
23 319 movement skills and routines (van Eijk 1998; Sadler-Smith and Shefy, 2007; Nonaka and van
24
25 320 Krogh, 2009; Kieft 2015). The Somatics Toolkit offers a movement-based methodology
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27 321 designed to incorporate, and learn from, the body as a research tool (see
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29 322 <http://somaticstoolkit.coventry.ac.uk>).

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36 324 Intriguingly, some biodynamic farmers are more comfortable with speaking about their
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38 325 feelings and the concept of intuition than are other organic farmers (Anja Vieweger, personal
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40 326 observation). Steiner (1967, 1995), founder of biodynamic agriculture, considered intuition the
41
42 327 highest stage of non-physical perception, and pivotal to the examining of one's own thoughts
43
44 328 in the quest for self-awareness. In agreement with Steiner, prominent western philosophers
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46 329 since the 17th century, including Henri Bergson (Bergson, 1911), Karl Popper (Jarvie et al.,
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48 330 2006) and Baruch de Spinoza (van Eijk, 2019) have described intuition as a method to attain
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50 331 deeper or higher knowledge.

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55 333 While biodynamic certification for farms only regulates physical practice requirements, the
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57 334 theory behind biodynamics provides systematic guidelines for self-observation and for

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3 335 developing intuition (von Diest, 2019). Steiner's (1995) '*hineinversetzung*' - placing one's
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5 336 awareness as if through the eyes of other beings and observing what happens inside oneself -
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7 337 is similar to using the entire human constitution to 'sense subtle energies' within the agro-
8
9 338 ecological landscape (Kieft, 2006, 2015, 2019).

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14 340 Interestingly, farmers say they feel better and/or healthier when practising intuitive farming,
15
16 341 and feel more connected with their community and nature (Kieft, 2006; Nuthall and Old, 2018).
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18 342 Sadler-Smith and Shefy (2007) suggest that 'the feeling' that an environment induces is
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20 343 important in training intuition, and note other positive outcomes, such as improved self-
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22 344 confidence, inter- and intra-personal sensitivity and metacognition.
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28 346 Nature connectedness is promising for improvements to farmer health and resilience, and the
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30 347 interrelated health and resilience of agroecosystems of which they are a part (Simaika and
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32 348 Samways, 2018). As individuals have regular experiences of oneness with nature, a gradual
33
34 349 and long-lasting shift in attitude towards nature and a more ecological worldview is facilitated,
35
36 350 enabling a paradigm shift from a more positivist one in which the farmer/human is a steward
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38 351 of nature, to perhaps a more mystical one in which farmers/humans feel unified with the rest
39
40 352 of nature (van Eijk, 1998). This bears in mind that connectedness with nature is a holistic
41
42 353 process that goes beyond only obtaining information about nature, and provides motivation and
43
44 354 a reliable predictor for environmentally responsible behaviour (Zylstra, 2014). Nature
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46 355 connectedness may thus enable farmers to be aware of, and manage, their emotional triggers,
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48 356 as well as think more creatively, which in turn, would benefit both analytic and intuitive
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50 357 thinking.
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58 359 **4. Appropriate methodologies for future research**
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3 360 Assuming farmers require and/or want research support in developing intuition, research
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5 361 methodologies that embrace farmer intuition would need to be both respectful and inclusive of
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7 362 different ways of knowing, and centralise the need for endogenous knowledge development in
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9 363 a given culture or region (van Eijk, 1998; ETC-COMPAS, 2007; COMPAS/UDS, 2008), such
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11 364 as approaches applied in the integrative scientific discipline and movement of agroecology
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14 365 (Pimbert, 2015). Here, researchers are co-inquirers in a reciprocal relationship with study
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16 366 participants (rather than subjects) (Chilisa, 2012; Curry and Kirwan, 2014; Madjidi, 2014). Of
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18 367 course, intuition on the part of the researcher would provide a latent resource to make key
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21 368 decisions in developing the research process (van Eijk, 1998; Madjidi, 2014; Rosenberg, 2017).

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25 370 If nature connectedness is involved in, or helps with, refining an intuitive connection for
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27 371 development of regenerative farm practices, there may be benefits in borrowing from fields of
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29 372 study like ecological psychology (informed by deep ecology) (Roszak et al., 1995), multi-
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31 373 species ethnography (Kirksey and Helmreich, 2010), animism (Harding, 2015) and ecofluency
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33 374 (von Diest, 2019). Studies like those of Madjidi (2014), Zylstra (2014) and van Eijk (1998),
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35 375 which use such approaches, provide theories and methodologies for facilitation and support,
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37 376 for both individual and group processes towards personal and collective transformation and
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39 377 evolution.

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45 379 **5. Summary and conclusions**

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51 381 Research shows that challenges to farm management are more complex and site-specific than can
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53 382 be accurately represented by standardised scientific models favoured by mainstream agriculture,
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55 383 and management decisions by analytical methods. Management decisions often require quick and
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57 384 accurate forecasts for complex situations that are seldom formally available. As cognitive analysis
58
59 385 takes longer and cannot fully calculate realistic risk, farmers must often rely on intuition. Intuition

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3 386 allows access to tacit knowledge, which, although not externalised, offers insight into holistic,
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5 387 tailored solutions.
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9 389 Although not new to farmers, intuition is a relatively new concept in agricultural research. The
10
11 390 few existing studies on this topic agree that many farmers have well-developed intuition,
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13 391 resulting in significant benefits, and all agree on the need to focus research on supporting
14
15 392 farmers to develop their intuition. This is not to replace, but rather to complement farmers'
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17 393 analytical processes. Importance of managing emotions and personal development are
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19 394 emphasized in the intuition development process, as well as the potential for improved
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21 395 connectedness with nature.
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28 397 What is needed is not more knowledge, but better knowing. If more farmers were to consciously
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30 398 and confidently leverage the latent, free resource of their intuition, they may be empowered to
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32 399 more easily make ecologically cohesive management decisions tailored to any given situation.
33
34 400 This could help re-embed farmers centrally within the agroecosystem, as the necessary step
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36 401 beyond them simply being perceived as recipients of external knowledge and acting as objective
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38 402 managers of farm systems. Focusing research on the emergent field of intuitive farming, offers
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40 403 stimulus for the paradigm shift called for to reinvigorate resilient agriculture.
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46 405 **References**

47
48 406 Altieri MA (1995) *Agroecology: the science of sustainable agriculture*. Boulder, CO:
49
50
51 407 Westview Press.

52
53 408 Apusigah AA (2011) Indigenous Knowledge, Cultural Values and Sustainable Development
54
55 409 in Africa. Paper presented at the *2nd Annual Ibadan Sustainable Development Summit*,
56
57 410 Nigeria, August 2011.

58
59 411 Bergson H (1911) *Creative Evolution*, Mitchell A (tr.). New York, NY: Henry Holt and
60

- 1
2
3 412 Company.
4
5 413 Boateng W (2006) Knowledge management working tool for agricultural extension: the case
6
7 414 of Ghana. *Knowledge Management for Development Journal* 2: 19-29.
8
9 415 Bolte A, Goschke T and Kuhl J (2003) Emotion and intuition: Effects of positive and negative
10
11 416 mood on implicit judgments of semantic coherence. *Psychological Science* 14: 416-421.
12
13 417 Bramley RGV (2009) Lessons from nearly 20 years of Precision Agriculture research,
14
15 418 development, and adoption as a guide to its appropriate application. *Crop Pasture Science*
16
17 419 60: 197-217.
18
19 420 Chilisa B (2012) *Indigenous Research Methodologies*. Los Angeles, CA: Sage Publications.
20
21 421 Chin-Yee B and Fuller J (2018) Clinical judgement: Multidisciplinary perspectives. *Journal of*
22
23 422 *Evaluation in Clinical Practice* 24: 635-637.
24
25 423 Code J (2018) Alternative agriculture: Innovations for growing and cultivating diverse ways of
26
27 424 knowing. In Zeunert J and Waterman T (eds) *Routledge Handbook of Landscape and*
28
29 425 *Food*. London: Routledge, pp. 125-137
30
31 426 COMPAS/UDS (2008) *Endogenous development in Africa: Towards a systematisation of*
32
33 427 *experiences*, Millar D, Apusigah AA and Boonzaijer C (eds). Leusden: COMPAS/UDS.
34
35 428 Curry N and Kirwan J (2014) The role of tacit knowledge in developing networks for
36
37 429 sustainable agriculture. *Sociologia Ruralis* 54: 341-361.
38
39 430 Dane E and Pratt M (2007) Exploring intuition and its role in managerial decision making.
40
41 431 *Academy of Management Review* 32: 35-54.
42
43 432 Döring TF, Vieweger A, Pautasso M, Vaarst M, Finckh MR and Wolfe MS (2013) Resilience
44
45 433 as a universal criterion of health. *Journal of the Science of Food and Agriculture* 95: 455-
46
47 434 465.
48
49 435 Douthwaite B, Keatinge JHD and Park JR (2001) Why promising technologies fail: the
50
51 436 neglected role of user innovation during adoption. *Research Policy* 30: 819-836.
52
53 437 Eastwood CR, Chapman DF and Paine MS (2006) From intuition to information - Management

- 1
2
3 438 information systems in Australian dairy farming. In: *Computers in Agriculture and*
4
5 439 *Natural Resources: Proceedings of the 4th World Congress*, Orlando, Florida, USA, July
6
7 440 2006.
8
9 441 Eastwood CR, Chapman DF and Paine MS (2012) Networks of practice for co-construction of
10
11 442 agricultural decision support systems: Case studies of precision dairy farms in Australia.
12
13 443 *Agricultural Systems* 108: 10-18.
14
15
16 444 ETC-COMPAS (2007) *Endogenous development in practice: towards well-being of people*
17
18 445 *and ecosystems*, Van t' Hooft K (ed). Leusden: ETC-COMPAS.
19
20
21 446 Roszak T, Gomes ME and Kanner AD (eds.) (1995) *Ecopsychology: Restoring the Earth*
22
23 447 *Healing the Mind*. San Francisco, CA: Sierra Club Books.
24
25
26 448 Haraway D (1988) Situated knowledges: The science question in feminism and the privilege
27
28 449 of partial perspective. *Feminist Studies* 14: 575–599.
29
30 450 Harding SP (2015) Towards an Animistic Science of the Earth. In *Handbook of Contemporary*
31
32 451 *Animism*, Harvey G (ed). London: Routledge.
33
34
35 452 Harvey MG and Novicevic MN (2002) The hypercompetitive global marketplace: the
36
37 453 importance of intuition and creativity in expatriate managers. *Journal of World Business*
38
39 454 37: 127-138.
40
41
42 455 Haverkort B (2010) The inter-university initiative CAPTURED: Bridging worldviews, ways
43
44 456 of learning and ways of knowing. *Journal of Ayurveda and Integrative Medicine* 1: 56-62.
45
46 457 HMI (Holistic Management International) (2013) Holistic Management Whole Farm/Ranch
47
48 458 Planning System. [https://holisticmanagement.org/wp-content/uploads/2013/02/HM-](https://holisticmanagement.org/wp-content/uploads/2013/02/HM-System-Highlights.a.pdf)
49
50 459 [System-Highlights.a.pdf](https://holisticmanagement.org/wp-content/uploads/2013/02/HM-System-Highlights.a.pdf). Accessed 15 November 2018.
51
52
53 460 Hochman Z and Carberry PS (2011) Emerging consensus on desirable characteristics of tools
54
55 461 to support farmers' management of climate risk in Australia. *Agricultural Systems* 104:
56
57 462 441–450.
58
59
60

- 1
2
3 463 Hodgkinson GP, Langan-Fox J, and Sadler-Smith E (2008) Intuition: A fundamental bridging
4
5 464 construct in the behavioural sciences. *British Journal of Psychology* 99: 1–27.
6
7 465 IAASTD (International Assessment of Agricultural Knowledge, Science and Technology for
8
9 466 Development). (2009) *Agriculture at a crossroads: A synthesis of the global and sub-*
10
11 467 *global IAASTD reports*, McIntyre BD, Herren HR, Wakhungu J and Watson RT (eds).
12
13 468 Washington, DC: Island Press.
14
15
16 469 Jarvie I, Milford K, Miller D (eds.) (2006) *Karl Popper: A Centenary Assessment Vol III:*
17
18 470 *Science*. Aldershot: Ashgate Publishing.
19
20
21 471 Kahneman D (2003) Maps of bounded rationality: Psychology for behavioral economics.
22
23 472 *American Economic Review* 93: 1449-1475.
24
25
26 473 Khatri N and Ng. HA (2000) The role of intuition in strategic decision making. *Human*
27
28 474 *Relations* 53: 57-86.
29
30 475 Kieft H (2006) Quantum Agriculture: bridging frontline physics and intuitive knowledge of
31
32 476 nature? In: *Moving Worldviews, reshaping sciences, policies and practices for endogenous*
33
34 477 *sustainable development*, Haverkort B and Reijntjes C (eds). Leusden: Compas Leusden.
35
36 478 pp. 209-218.
37
38
39 479 Kieft H (2015) Intuitive farming: Towards a new vision on nature. Proceedings of the XI
40
41 480 International People-Plant Symposium on Diversity: Towards a New Vision on Nature.
42
43 481 *Acta Horticulturae* 1093: 179-194.
44
45
46 482 Kieft H (2019) *Quantum Leaps in Agriculture*. LAP LAMBERT Academic Publishing.
47
48
49 483 Kirksey E and Helmreich S (2010) "The Emergence of Multispecies Ethnography." From the
50
51 484 Editorial Office, Cultural Anthropology website, June 14, 2010.
52
53 485 <https://culanth.org/fieldsights/277-the-emergence-of-multispecies-ethnography>. Accessed
54
55 486 24 September 2017.
56
57
58 487 Knowler D and Bradshaw B (2007) Farmers' adoption of conservation agriculture: A review
59
60 488 and synthesis of recent research. *Food Policy* 32: 25–48.

- 1
2
3 489 Lufityanto G, Donkin C and Pearson J (2016) Measuring intuition: Nonconscious emotional
4
5 490 information boosts decision accuracy and confidence. *Psychological Science* 27: 622–634.
6
7 491 Lunneryd D (2003) Unique decision making with focus on information use. The case of
8
9 492 converting to organic milk production. *Acta Universitatis Agriculturae Suecia; Agraria*
10
11 493 405, SLU, Uppsala, Sweden. (<http://epsilon.slu.se/index.html>).
12
13
14 494 Lynch T, Gregor S and Midmore D (2000) Intelligent support systems in agriculture: how can
15
16 495 we do better? *Australian Journal of Experimental Agriculture* 40: 609–620.
17
18 496 Makondo CC and Thomas DSG (2018) Linking indigenous knowledge with western science
19
20 497 for effective adaptation. *Environmental Science and Policy* 88: 83-91.
21
22
23 498 McCown RL, Carberry PS, Dalglish NP, Foale MA and Hochman Z (2012) Farmers use
24
25 499 intuition to reinvent analytic decision support for managing seasonal climatic variability.
26
27 500 *Agricultural Systems* 106: 33–45.
28
29
30 501 Nonaka I and van Krogh G (2009) Tacit knowledge and knowledge conversion: Controversy
31
32 502 and advancement in organizational knowledge creation theory. *Organization Science* 20:
33
34 503 635-652.
35
36
37 504 Nuthall PL (2012) The intuitive world of farmers – The case of grazing management systems
38
39 505 and experts. *Agricultural Systems* 107: 65–73.
40
41
42 506 Nuthall PL (2013) *The Intuitive Farmer: Inspiring Management Success*. Portland, OR: 5M
43
44 507 Publishing.
45
46 508 Nuthall PL and Old KM (2018) Intuition, the farmers’ primary decision process. A review and
47
48 509 analysis. *Journal of Rural Studies* 58: 28-38.
49
50
51 510 OECD (Organisation for Economic Co-operation and Development) (2012) *Farmer*
52
53 511 *Behaviour, Agricultural Management and Climate Change*. Paris: OECD Publishing.
54
55 512 Öhlmér B (2007) The Need and Design of Computerized Farm Management Tools – Lessons
56
57 513 Learned from a Swedish Case. Working Paper Series 2007:5. Department of Economics,
58
59 514 SLU, Uppsala. (<https://pub.epsilon.slu.se/3027/>).
60

- 1
2
3 515 Öhlmér B, Olson K and Brehmer B (1998) Understanding farmers' decision making processes
4
5 516 and improving managerial assistance. *Agricultural Economics* 18: 273-290.
6
7 517 Parry GA (2005) Native wisdom in a quantum world. *Shift* 9: 29-33.
8
9 518 Paxton R, Klimek M, Vieweger A, Döring T, Bloch R, Bachinger J and Woodward L (2017)
10
11 519 The role of intuition in managing organic farm system health. In: *Innovative Research for*
12
13 520 *Organic 3.0 - Volume 1: Proceedings of the Scientific Track at the Organic World*
14
15 521 *Congress 2017*, Rahmann et al. G (eds) November, 2017, Delhi, India. Thünen Report,
16
17 522 No. 54,1.
18
19
20
21 523 Pimbert M (2015) Agroecology as an alternative vision to conventional development and
22
23 524 climate-smart agriculture. *Development* 58: 286–298.
24
25 525 Prokopy LS, Floress K, Klotthor-Weinkauff D and Baumgart-Getz A (2008) Determinants of
26
27 526 agricultural best management practice adoption: Evidence from the literature. *Journal of*
28
29 527 *Soil and Water Conservation September* 63: 300-311.
30
31
32 528 Robert M, Dury J, Thomas A, Therond O, Sekhar M, Badiger A, Ruiz L and Bergez J-E (2016)
33
34 529 CMFDM: A methodology to guide the design of a conceptual model of farmers' decision-
35
36 530 making processes. *Agricultural Systems* 148: 86–94.
37
38
39 531 Rosenberg LL (2017) Turi kumwe (we are together): A transdisciplinary exploration of the
40
41 532 Burundian specialty coffee sector and its sustainability challenges. PhD Dissertation.
42
43 533 Stellenbosch University, South Africa.
44
45
46 534 Sadler-Smith E and Shefy E (2007) Developing intuitive awareness in management education.
47
48 535 *Academy of Management Learning & Education* 6: 186-205.
49
50
51 536 Salas E, Rosen MA and DiazGranados D (2009) Expertise-based intuition and decision making
52
53 537 in organizations. *Journal of Management* 36: 941-973.
54
55 538 Simaika JP and M Samways M (2018) Insect conservation psychology. *Journal of Insect*
56
57 539 *Conservation* 22: 635-642.
58
59
60 540 Steiner R (1967) *The Stages of Higher Knowledge*. Hudson: Anthroposophic Press.

- 1
2
3 541 Steiner R (1995) *Intuitive Thinking as a Spiritual Path; A Philosophy of Freedom*. Centennial
4
5 542 Edition. Hudson: Anthroposophic Press.
6
7 543 UNCTAD (United Nations Conference on Trade and Development) (2013) Trade
8
9 544 and Environment Review. Wake up before it is too late: Make agriculture truly sustainable
10
11 545 now for food security in a changing climate. United Nations Publication.
12
13 546 (unctad.org/en/PublicationsLibrary/ditcted2012d3_en.pdf).
14
15
16 547 Van Eijk T (1998) *Farming Systems Research and Spirituality*. PhD dissertation. Wageningen
17
18 548 University, the Netherlands.
19
20
21 549 Van Eijk T (2019) *Spinoza in the light of spiritual development*. Lulu.com
22
23 550 Vangala RNK, Hiremath BN and Banerjee A (2014) A theoretical framework for knowledge
24
25 551 management in Indian agricultural organizations. Article 6, In: *Proceedings of the 2014*
26
27 552 *International Conference on Information and Communication Technology for Competitive*
28
29 553 *Strategies*, November 2014, Udaipur, Rajasthan, India.
30
31
32 554 Von Diest SG (2019) Could biodynamics help bridge the gap in developing farmer intuition?
33
34 555 *Open Agriculture* 4: 391-399.
35
36
37 556 Zylstra MJ, Knight AT, Esler KJ and Lesley LLL (2014) Connectedness as a core conservation
38
39 557 concern: An interdisciplinary review of theory and a call for practice. *Springer Science*
40
41 558 *Review* 2: 119–143.
42
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1 A call to focus on farmer intuition for improved management decision making

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3

4 Abstract

5

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

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

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

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

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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

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3 53 to provide knowledge, accumulated through observable data gathered in controlled and
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5 54 repeatable experiments (van Eijk, 1998). This results in explicit knowledge, i.e. formal
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7 55 knowledge that can be articulated, documented, codified, and easily transferred in a systematic
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9 56 and tangible form using words, numbers and formulae, and disseminated through, for example,
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11 57 instruction manuals (Boateng, 2006; Nonaka and van Krogh, 2009; Vangala et al., 2014).
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16 59 The paradigm shift called for in the United Nations Conference on Trade and Development
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18 60 (UNCTAD) Trade and Environment Review (2013) report invites examination of how
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20 61 knowledge that is thought by modern science to be appropriate for sustainable agriculture is
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22 62 generated and used. Going further, van Eijk (1998) and Code (2018) identify the need to
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24 63 question the ontology and epistemology of mainstream agricultural research, and to recognise
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26 64 and include the role of interior knowledge sources.
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32 66 This has been addressed, to some extent, when agricultural research began to acknowledge the
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34 67 constructivist paradigm (constructed nature of reality) in the 1980s (van Eijk, 1998), including
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36 68 through the exploration of indigenous research methods (Apusigah, 2011; Chilisa, 2012).
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39 69 However, tacit knowledge still has not yet been significantly addressed (van Eijk, 1998; Boateng,
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41 70 2006; Curry and Kirwan, 2014; Vangala et al., 2014). Tacit knowledge is intangible, personal,
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43 71 often experiential and informal in nature, involving conscious and unconscious awareness of
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45 72 perspective, personal beliefs, values and innate knowing. It is found in traditions, customs and
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47 73 *savoir-faire* (adaptive ability to determine appropriate action). It can refer to the decision rules
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49 74 stored in the mind, but is implicit in nature and cannot always be articulated, codified, or
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51 75 transferred. Yet it can be accessed through intuitive processes (Boateng, 2006; Nonaka and van
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53 76 Krogh, 2009).
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60 78 *2.2. Value of using intuition in decision making*

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5 80 Dane and Pratt (2007) define intuition as ‘affectively-charged judgements that arise through
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7 81 rapid, non-conscious, and holistic associations’, or ‘the provision of a conclusion reached
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9 82 without formal analysis’. Perhaps a simpler and more apt definition of intuition is ‘knowing
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11 83 without knowing how you know’, or ‘knowing from within’ (Hodgkinson et al., 2008). To date,
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14 84 most evidence on the value of intuition comes from the fields of psychology and business
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16 85 management, and is recognised as critical in hyper-competitive business environments (Harvey
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18 86 et al., 2002) and clinical judgement in medicine (Chin-Yee and Fuller, 2018).
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23 88 In the field of economics, Kahneman (2003) observes that decision makers are aware of limited
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25 89 information, and most judgements and decisions are made intuitively. He presents a map of
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27 90 ‘cognition architecture’, in which the characteristics of intuitive and reasoning (rational/logical)
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29 91 systems are summarised. Here, intuition resembles perception, and both are fast, automatic,
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31 92 associative, and reference-dependent, or stimulus-bound. Reasoning, by contrast, is slow,
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33 93 controlled, and neutral, and both intuition and reason are informed by experience. He emphasises
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35 94 that intuition can be powerful and accurate, but applying it effectively requires prolonged practice.
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39 95 *Given our perspective on the constructivist, subjective nature of reality, we would contend*
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41 96 *Kahneman’s (2003) identification of reasoning as being neutral.*
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46 98 Overall, intuition appears to be an involuntary, immediate and inevitable part of all decisions,
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48 99 which can complement logical cognition, and can be highly useful when there is a time constraint
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51 100 on gathering (potentially unreliable) information (Khatri and Ng, 2000). It can boost accuracy,
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53 101 confidence, and speed in the decision-making process (Lufityanto et al., 2016). This suggests that
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55 102 applying intuition, and thus accessing tacit forms of knowledge, holds potential for improved farm
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57 103 management decision making
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3 105 *2.3 Learning from traditional and indigenous ecological knowledge systems*
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7 107 Many traditional and indigenous cultures worldwide have evolved a highly integrated, holistic,
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9 108 intuitive understanding of the complex natural systems in which they live, and maintaining a
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11 109 dialogue with these systems is crucial for managing food production landscapes (Parry, 2005;
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13 110 Apusigah, 2011). Small-scale and subsistence farmers use their tacit understanding to adapt to
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15 111 increasingly unpredictable climatic conditions, such as drought, thereby increasing the
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17 112 resilience of their agroecosystems (Kieft, 2006, 2015; IAASTD 2009; Makondo and Thomas,
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19 113 2018). Resilience (the ability to remain functional under stress) is an important criterion of
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21 114 health and adaptability in agricultural systems (Döring et al., 2013), and is crucial for farmers
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23 115 to consider in their decision making, especially in regions with rapidly-changing climatic
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25 116 conditions.
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30 117 This ‘situational knowledge’ (Haraway 1988) is generated through experience, language,
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32 118 culture and tradition *in situ*, and through more than the five physical senses. These stocks of
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34 119 intuition, or cultural capital (Hogarth, 2010), are the product of tacit learning, and expand on,
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36 120 and contribute to, a more holistic, pragmatic knowledge base than the (explicit) knowledge
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38 121 gained through modern science’s overemphasis on the sense of vision and observation.
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44 123 Several global organisations have called for the protection and utilization of these knowledge
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46 124 systems, arising from their value in evolving adaptive agricultural solutions and addressing global
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48 125 food security. For example, in 2002, the Food and Agriculture Organization initiated the Globally
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50 126 Important Agricultural Heritage Systems (GIAHS) programme, to safeguard and support
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52 127 indigenous and traditional knowledge systems at risk of disappearing through the spread of
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54 128 industrialised agriculture. GIAHS policy suggestions are already being applied, as in the case of
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56 129 the inter-university initiative Capacity and Theory Building of Universities and Research Centres
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3 130 on Endogenous Development (CAPTURED), which has formulated curricula to include ancient
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5 131 wisdom and intuitive knowing into higher education (Haverkort, 2010).
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9 133 *2.4 Potential risk of externalising tacit knowledge*
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14 135 Organization science places both explicit and tacit knowledge along a continuum, and considers
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16 136 that the less extreme forms of tacit knowledge may be externalized or converted (Nonaka and van
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18 137 Krogh, 2009), to allow for the expansion of knowledge beyond what exists in one individual or
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20 138 community. Through participatory research approaches, some tacit knowledge embedded in
21
22 139 traditional and indigenous ecological knowledge systems has been externalised for improving and
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24 140 developing sustainable agricultural practices (Eastwood et al., 2012; Curry and Kirwan, 2014).
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28 141 Steps such as the GIAHS programme contribute greatly to understanding and using the various
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30 142 knowledge bases of farmers worldwide. However, apart from the innate difficulty in expressing
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32 143 tacit knowledge, building mutual trust for an effective ‘dialogue of wisdom’ with those holding
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34 144 tacit knowledge is not easy. Knowledge holders may be reluctant to share with western scientists,
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36 145 expressing a lack of confidence in its appropriate use outside of their own cultural and spiritual
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38 146 context. For example, knowledge about local plants shared with researchers of international seed
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40 147 businesses has often been exploited for profit (Henk Kieft, personal observation).
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44 149 Additionally, because such embedded knowledge is situational, practices developed from them
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46 150 are appropriate to local cultures and regional conditions, and not well suited to adapting to, or
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48 151 scaling up within, other cultures and regions (Chilisa, 2012). And because of the internal,
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50 152 experiential nature of both intuition and tacit knowledge, an externalisation process could alter or
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52 153 dilute the value of such knowledge (Hodgkinson et al., 2008).
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3 155 **This location-specificity is at odds with the positivist paradigm of mainstream agriculture.** Could
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5 156 support for farmers to individually access and apply tacit knowledge circumvent this? Certainly,
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7 157 farmers would be imbued with more agency and autonomy than is currently the case.
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11 159 **3. Reviewing the role of intuition in farmer decision making**

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16 161 To assess how existing agricultural research addresses intuition in farmer decision making, we
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18 162 performed a search on the scientific databases Scopus and Web of Science, cross-referencing
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20 163 the keywords ‘intuition’ with ‘agriculture’ and ‘farming’. Filtering 60 search results for
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22 164 relevance to management decision making yielded a total of seven papers, all published in the
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24 165 16 years up until 2019. We included a further two articles from conference proceedings.
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29 167 *3.1 The need to reconsider the analytic approach to supporting farmer decision making*

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34 169 Five of the seven articles from our initial search were associated with the development and use
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36 170 of analytical decision support systems in industrialised countries. Using a rational/logical
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38 171 approach based on cognitive task analysis, formal tools using information communication
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40 172 technologies have been developed to bridge the knowledge extension gap between agricultural
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42 173 science and farming practice to streamline management decisions. Despite the slow uptake of
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44 174 such support systems in many countries, two studies found that many systems have been
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46 175 successfully adopted (Bramley, 2009; Eastwood et al., 2012).
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53 177 Several authors agree that formal tools are rarely designed with a detailed understanding of the
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55 178 relationship between farmers’ specific knowledge, the decisions they make and the actions they
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57 179 take, and farmers are often not consulted in the design process until release of the final product
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59 180 (Lynch et al., 2000; Öhlmér, 2007; Robert et al., 2016). As a result, early use of new

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3 181 information management systems is often stressful for farmers accustomed to using an
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5 182 intuitive, experience-based management style, and these systems are subsequently not
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7 183 prioritised (Eastwood et al., 2006). Five studies found that farmers often do not adopt
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9 184 formalised tools as expected, and largely prefer an intuitive approach to an analytic system
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11 185 (Lunneryd, 2003; Öhlmér, 2007; McCown et al., 2012; Kieft, 2015; Nuthall and Old, 2018).

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16 187 In an example from Sweden, the adoption rate of a computer-based tool aimed at analytic
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18 188 thinking to support farmers' decision making, developed in a research programme spanning
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20 189 three decades, was considerably lower than expected (Öhlmér, 2007). Similarly, in Sweden,
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22 190 the process of gathering information on the strategic decision making by farmers to convert
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24 191 from conventional to organic milk production in Sweden had not been adapted to their specific
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26 192 needs (Lunneryd, 2003). Both Lunneryd (2003) and Öhlmér (2007) found that farmers mostly
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28 193 rely on intuition for decision making.

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34 195 McCown et al. (2012) found that Australian farmers were initially enthusiastic about adopting
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36 196 analytic decision support system for measuring soil water and managing climatic variability.
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38 197 However, in practice, they used the system to hone their intuitive ability, to which they returned
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40 198 and relied upon heuristically, only using the analytic system in exceptional cases. Similarly, in
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42 199 New Zealand, the most successful (efficient and/or profitable) stock-cattle farmers relied less
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44 200 on formal technological tools designed to aid their practical decision making, and instead
45
46 201 developed a personalised expert system, with intuition being the primary driver (Nuthall,
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48 202 2012). This expert system was a technology-based encapsulation of decision rules used by
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50 203 farmer experts, through a question and answer system based on explicit knowledge. While
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52 204 studying farmers' expert systems was valuable, there was an element of impracticality when
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54 205 basing development of technological tools for grazing management, since farmers preferred to
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56 206 rely on intuition.

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5 208 Farmers' knowledge is not static, nor are their decisions likely to be made in the same way over
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7 209 time as their experience grows, their knowledge base evolves, and as external environments
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9 210 become more challenging (Eastwood et al., 2012). This means that formal decision support tools
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11 211 would need to be constantly re-evaluated and adapted to efficiently support farmers (Douthwaite
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14 212 et al., 2001; Eastwood et al., 2012).

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18 214 We have seen that farmer decision making is a complex process involving values, goals,
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20 215 observation, intuition and intention, yet management programmes that do not consider these
21
22 216 factors are less likely to be effective (van Eijk, 1998; OECD, 2012). Hochman and Carberry
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24 217 (2011) argue that support systems should allow users to experiment with options that satisfy their
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26 218 needs, and develop intuition instead of replacing it with optimised recommendations.
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32 220 *3.2 The call to focus research attention on the development of farmer intuition*

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37 222 Nuthall and Old (2018) found that successful farm managers made most of their decisions using
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39 223 their well-developed intuitive ability, i.e. they could confidently apply their intuition to make
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41 224 a successful decision. They present an original model to explain intuition, using data from 818
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43 225 farms in New Zealand and based on influencing variables, including experience, feedback and
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45 226 repetition, training and mentoring, reflection and self-critique, intelligence and personality,
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47 227 objectives and risk attitude, observation and anticipation skills.
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53 229 Farmers often describe intuition as crucial for farm health management. In a study of farm
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55 230 health among 79 organic farmers in Austria, Germany, and the UK, health was seen as an
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57 231 interconnected system based on close observation and decision-making processes (Paxton et
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59 232 al., 2017). One of ten key factors identified for healthy farming systems was the development

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3 233 of intuition and the associated ability for self-observation. As one farmer explained: “We’re
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5 234 always talking about things that are not actually tangible... this is something older, something
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7 235 that we have lost... intuition should be the first point concerning the importance for health”.
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9 236 (Paxton et al, 2017: 83). Other farmers considered that intuition allowed for customised
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11 237 practical decisions (Paxton et al., 2017). Since resilience and health are interdependent (Döring
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14 238 et al., 2013), this suggests that farmers may use intuition to build resilience.

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18 240 Research has showed that farmers in the Netherlands, Brazil, Peru and Sri Lanka secured
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21 241 considerable benefits by relying largely on intuition (Kieft, 2006, 2015). Surveyed farmers
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23 242 claimed that, while proficiency and experience in practical farming skills were important, their
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25 243 success stemmed mainly from using their intuition to inform and accelerate decisions. They
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28 244 reported earlier disease detection and improved disease resilience, enabling a reduction in
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30 245 chemical inputs and water use, resulting in improved yields and product quality (specifically
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32 246 nutritional value and shelf-life), and higher input efficiency, in both plant and animal
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35 247 production. In dairy farming, benefits such as quieter animals, lower antibiotic use and
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37 248 veterinary costs, higher calf survival rates, improved immune response, and more efficient feed
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39 249 conversion rates were reported. Many of these farmers also benefitted from an improved work-
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42 250 life balance and a deeper sense of satisfaction, as well as minimising environmental impact and
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44 251 working in closer harmony with nature. All the surveyed farmers operated intuitively, and the
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46 252 study concluded that farmer intuition should be accepted, respected, and actively enhanced.

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50 254 For too long, agricultural research has seen intuition as non-scientific and problematic (van
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53 255 Eijk, 1998). The growing recognition that it deserves more focused attention from researchers
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55 256 and farmers does not imply that farmers should use their analytical skills less, or that research
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58 257 into the analytic decision processes of farmers should discontinue. However, there is a gap in
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60 258 understanding how to support farmers to confidently and consciously use their intuition. Such

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3 259 support would be especially important for small-scale and subsistence farmers who may not
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5 260 have access to external tools (Boateng, 2006).
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9 262 Because farmers generally prefer quick and simple vs. detailed and elaborate analysis, and lean
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11 263 towards incremental implementation (Öhlmér et al., 1998), cognitive analysis is favourable when
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13 264 tasks are analytically simple, yet, as analytical complexity increases, intuition becomes more
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15 265 advantageous, being quick and effortless (Hogarth, 2010). This is recognised by some industry
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17 266 advisors, such as the whole farm/ranch planning framework developed by Holistic Management
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19 267 International. Of their seven tests that a holistic management decision should pass, the last and
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21 268 most important is the “gut check”, which asks “not what you think, but how you feel about an
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23 269 action or decision” (HMI, 2013).
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30 271 *3.3 Potential challenges of relying on intuition*
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34 273 That intuition is not easily verbalized presents a potential problem for farms with large
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36 274 management structures and teams, as the whole team needs to be aware that this ability is being
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38 275 consciously used (Öhlmér, 2007). Composition of the management team in terms of levels of
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40 276 expertise would impact how intuitive insights are shared in the team, and those with greater
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42 277 managerial responsibility may require a better developed intuitive ability, which needs to
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44 278 reflect in clear roles and responsibilities within the team (Salas et al. 2009).
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51 280 Khatri and Ng (2000) point out that an intuitive decision-maker may be accused of being overly
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53 281 influenced by emotions. While intuitive decisions are not emotional per se, they can be affected
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55 282 by the subtle priming of emotions (Hogarth, 2010). According to Bolte et al. (2003), a positive
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57 283 mood improves intuitive coherence judgments, whereas the performance level of intuition,
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3 284 while in a negative mood, can be equal to chance. Kahneman (2003) highlights the importance
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5 285 of managing one's emotional triggers and bias, as also pointed out by (Nuthall and Old, 2018).
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9 287 Hogarth (2010) suggests that reliance on intuition may be dysfunctional if the environment in
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11 288 which it is used is significantly different to the one in which the intuitive ability was trained,
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14 289 and that people's intuition cannot be trained to handle situations with which they not are
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16 290 familiar. Yet it plays a role in creative decision making in new, dynamic or complex situations,
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18 291 such as is typically experienced in agroecological systems, and novices have strong intuitions
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21 292 that could be fostered (Salas et al., 2009). So, honing intuition in any environment might be a
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23 293 helpful tool for farmers with little or no prior experience, such as young or entrant farmers.
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25 294 Intuition may be fallible, and the true success rate of intuition is unknown (Salas et al., 2009;
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28 295 Hogarth, 2010). However, when used frequently over time and integrating reflective processes,
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30 296 farmers become more adept at trusting their intuition, increasing in confidence and reliability
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32 297 (Sadler-Smith and Shefy, 2007; Lufityanto et al., 2016).
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37 299 *3.4 Developing intuition: the role of personal development and nature connectedness*

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41 301 Based on extensive research, the handbook *The Intuitive Farmer: Inspiring Management*
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43 302 *Success* (Nuthall, 2016) offers principles and practices for improving intuition for farm
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45 303 management, and is presented in an accessible narrative format. Here, high managerial ability
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47 304 requires excellent technical knowledge in the first instance, but knowing how to apply decision
48
49 305 methods that lead to success is critical. 'Informed intuition' requires experiencing appropriate
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51 306 lessons repeatedly, together with reviewing efficient decisions by both oneself and others.
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53 307 Developing confident and informed intuition depends on gaining practical experience,
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55 308 developing observation and anticipation skills, practicing structured reflection and self-
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3 309 critique, as well as consulting with professionals, friends and family for both personal and
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5 310 professional feedback.

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9 312 People vary in their intuitive abilities, due to genetics, upbringing and bias, but most humans
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11 313 have the ability to engage in reflexive processes, which are crucial to developing informed
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13 314 intuition (Nuthall and Old, 2018). The importance of personal transformation in developing
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15 315 intuition, which includes learning to manage emotions and bias which might influence
16
17 316 intuition, has been emphasized by various authors. The most effective techniques for personal
18
19 317 transformation include journaling, meditation (particularly Transcendental Meditation),
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21 318 practicing mindfulness, and developing somatic awareness through tactile experiences and
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23 319 movement skills and routines (van Eijk 1998; Sadler-Smith and Shefy, 2007; Nonaka and van
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25 320 Krogh, 2009; Kieft 2015). The Somatics Toolkit offers a movement-based methodology
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27 321 designed to incorporate, and learn from, the body as a research tool (see
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29 322 <http://somaticstoolkit.coventry.ac.uk>).

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37 324 Intriguingly, some biodynamic farmers are more comfortable with speaking about their
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39 325 feelings and the concept of intuition than are other organic farmers (Anja Vieweger, personal
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41 326 observation). Steiner (1967, 1995), founder of biodynamic agriculture, considered intuition the
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43 327 highest stage of non-physical perception, and pivotal to the examining of one's own thoughts
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45 328 in the quest for self-awareness. In agreement with Steiner, prominent western philosophers
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47 329 since the 17th century, including Henri Bergson (Bergson, 1911), Karl Popper (Jarvie et al.,
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49 330 2006) and Baruch de Spinoza (van Eijk, 2019) have described intuition as a method to attain
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51 331 deeper or higher knowledge.

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57 333 While biodynamic certification for farms only regulates physical practice requirements, the
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59 334 theory behind biodynamics provides systematic guidelines for self-observation and for

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3 335 developing intuition (von Diest, 2019). Steiner's (1995) '*hineinversetzung*' - placing one's
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5 336 awareness as if through the eyes of other beings and observing what happens inside oneself -
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7 337 is similar to using the entire human constitution to 'sense subtle energies' within the agro-
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9 338 ecological landscape (Kieft, 2006, 2015, 2019).

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14 340 Interestingly, farmers say they feel better and/or healthier when practising intuitive farming,
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16 341 and feel more connected with their community and nature (Kieft, 2006; Nuthall and Old, 2018).
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18 342 Sadler-Smith and Shefy (2007) suggest that 'the feeling' that an environment induces is
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20 343 important in training intuition, and note other positive outcomes, such as improved self-
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22 344 confidence, inter- and intra-personal sensitivity and metacognition.
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28 346 Nature connectedness is promising for improvements to farmer health and resilience, and the

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30 347 interrelated health and resilience of agroecosystems of which they are a part (Simaika and
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32 348 Samways, 2018). *As individuals have regular experiences of oneness with nature, a gradual
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34 349 and long-lasting shift in attitude towards nature and a more ecological worldview is facilitated,
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36 350 enabling a paradigm shift from a more positivist one in which the farmer/human is a steward
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38 351 of nature, to perhaps a more mystical one in which farmers/humans feel unified with the rest
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40 352 of nature (van Eijk, 1998).* This bears in mind that connectedness with nature is a holistic
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42 353 process that goes beyond only obtaining information about nature, and provides motivation and
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44 354 a reliable predictor for environmentally responsible behaviour (Zylstra, 2014). Nature
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46 355 connectedness may thus enable farmers to be aware of, and manage, their emotional triggers,
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48 356 as well as think more creatively, which in turn, would benefit both analytic and intuitive
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50 357 thinking.
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57 359 **4. Appropriate methodologies for future research**

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3 360 Assuming farmers require and/or want research support in developing intuition, research
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5 361 methodologies that embrace farmer intuition would need to be both respectful and inclusive of
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7 362 different ways of knowing, and centralise the need for endogenous knowledge development in
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9 363 a given culture or region (van Eijk, 1998; ETC-COMPAS, 2007; COMPAS/UDS, 2008), such
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11 364 as approaches applied in the integrative scientific discipline and movement of agroecology
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14 365 (Pimbert, 2015). Here, researchers are co-inquirers in a reciprocal relationship with study
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16 366 participants (rather than subjects) (Chilisa, 2012; Curry and Kirwan, 2014; Madjidi, 2014). Of
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18 367 course, intuition on the part of the researcher would provide a latent resource to make key
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21 368 decisions in developing the research process (van Eijk, 1998; Madjidi, 2014; Rosenberg, 2017).
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23 369
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25 370 If nature connectedness is involved in, or helps with, refining an intuitive connection for
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27 371 development of regenerative farm practices, there may be benefits in borrowing from fields of
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29 372 study like ecological psychology (**informed by deep ecology**) (Roszak et al., 1995), multi-
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31 373 species ethnography (Kirksey and Helmreich, 2010), animism (Harding, 2015) and ecofluency
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33 374 (von Diest, 2019). Studies like those of Madjidi (2014), Zylstra (2014) and van Eijk (1998),
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35 375 which use such approaches, provide theories and methodologies for facilitation and support,
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37 376 for both individual and group processes towards personal and collective transformation and
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39 377 evolution.
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46 379 **5. Summary and conclusions**

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51 381 Research shows that challenges to farm management are more complex and site-specific than can
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53 382 be accurately represented by standardised scientific models favoured by mainstream agriculture,
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55 383 and management decisions by analytical methods. Management decisions often require quick and
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57 384 accurate forecasts for complex situations that are seldom formally available. As cognitive analysis
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59 385 takes longer and cannot fully calculate realistic risk, farmers must often rely on intuition. Intuition

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3 386 allows access to tacit knowledge, which, although not externalised, offers insight into holistic,
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5 387 tailored solutions.
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9 389 Although not new to farmers, intuition is a relatively new concept in agricultural research. The
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11 390 few existing studies on this topic agree that many farmers have well-developed intuition,
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13 391 resulting in significant benefits, and all agree on the need to focus research on supporting
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15 392 farmers to develop their intuition. This is not to replace, but rather to complement farmers'
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17 393 analytical processes. Importance of managing emotions and personal development are
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19 394 emphasized in the intuition development process, as well as the potential for improved
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21 395 connectedness with nature.
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28 397 What is needed is not more knowledge, but better knowing. If more farmers were to consciously
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30 398 and confidently leverage the latent, free resource of their intuition, they may be empowered to
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32 399 more easily make ecologically cohesive management decisions tailored to any given situation.
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34 400 This could help re-embed farmers centrally within the agroecosystem, as the necessary step
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36 401 beyond them simply being perceived as recipients of external knowledge and acting as objective
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38 402 managers of farm systems. Focusing research on the emergent field of intuitive farming, offers
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40 403 stimulus for the paradigm shift called for to reinvigorate resilient agriculture.
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44 404

45 405 **References**

46
47
48 406 Altieri MA (1995) *Agroecology: the science of sustainable agriculture*. Boulder, CO:
49
50
51 407 Westview Press.

52
53 408 Apusigah AA (2011) Indigenous Knowledge, Cultural Values and Sustainable Development
54
55 409 in Africa. Paper presented at the *2nd Annual Ibadan Sustainable Development Summit*,
56
57 410 Nigeria, August 2011.

58
59 411 Bergson H (1911) *Creative Evolution*, Mitchell A (tr.). New York, NY: Henry Holt and
60

- 1
2
3 412 Company.
4
5 413 Boateng W (2006) Knowledge management working tool for agricultural extension: the case
6
7 414 of Ghana. *Knowledge Management for Development Journal* 2: 19-29.
8
9 415 Bolte A, Goschke T and Kuhl J (2003) Emotion and intuition: Effects of positive and negative
10
11 416 mood on implicit judgments of semantic coherence. *Psychological Science* 14: 416-421.
12
13 417 Bramley RGV (2009) Lessons from nearly 20 years of Precision Agriculture research,
14
15 418 development, and adoption as a guide to its appropriate application. *Crop Pasture Science*
16
17 419 60: 197-217.
18
19 420 Chilisa B (2012) *Indigenous Research Methodologies*. Los Angeles, CA: Sage Publications.
20
21 421 Chin-Yee B and Fuller J (2018) Clinical judgement: Multidisciplinary perspectives. *Journal of*
22
23 422 *Evaluation in Clinical Practice* 24: 635-637.
24
25 423 Code J (2018) Alternative agriculture: Innovations for growing and cultivating diverse ways of
26
27 424 knowing. In Zeunert J and Waterman T (eds) *Routledge Handbook of Landscape and*
28
29 425 *Food*. London: Routledge, pp. 125-137
30
31 426 COMPAS/UDS (2008) *Endogenous development in Africa: Towards a systematisation of*
32
33 427 *experiences*, Millar D, Apusigah AA and Boonzaijer C (eds). Leusden: COMPAS/UDS.
34
35 428 Curry N and Kirwan J (2014) The role of tacit knowledge in developing networks for
36
37 429 sustainable agriculture. *Sociologia Ruralis* 54: 341-361.
38
39 430 Dane E and Pratt M (2007) Exploring intuition and its role in managerial decision making.
40
41 431 *Academy of Management Review* 32: 35-54.
42
43 432 Döring TF, Vieweger A, Pautasso M, Vaarst M, Finckh MR and Wolfe MS (2013) Resilience
44
45 433 as a universal criterion of health. *Journal of the Science of Food and Agriculture* 95: 455-
46
47 434 465.
48
49 435 Douthwaite B, Keatinge JHD and Park JR (2001) Why promising technologies fail: the
50
51 436 neglected role of user innovation during adoption. *Research Policy* 30: 819-836.
52
53 437 Eastwood CR, Chapman DF and Paine MS (2006) From intuition to information - Management

- 1
2
3 438 information systems in Australian dairy farming. In: *Computers in Agriculture and*
4
5 439 *Natural Resources: Proceedings of the 4th World Congress*, Orlando, Florida, USA, July
6
7 440 2006.
8
9 441 Eastwood CR, Chapman DF and Paine MS (2012) Networks of practice for co-construction of
10
11 442 agricultural decision support systems: Case studies of precision dairy farms in Australia.
12
13 443 *Agricultural Systems* 108: 10-18.
14
15
16 444 ETC-COMPAS (2007) *Endogenous development in practice: towards well-being of people*
17
18 445 *and ecosystems*, Van t' Hooft K (ed). Leusden: ETC-COMPAS.
19
20
21 446 Roszak T, Gomes ME and Kanner AD (eds.) (1995) *Ecopsychology: Restoring the Earth*
22
23 447 *Healing the Mind*. San Francisco, CA: Sierra Club Books.
24
25
26 448 Haraway D (1988) Situated knowledges: The science question in feminism and the privilege
27
28 449 of partial perspective. *Feminist Studies* 14: 575–599.
29
30 450 Harding SP (2015) Towards an Animistic Science of the Earth. In *Handbook of Contemporary*
31
32 451 *Animism*, Harvey G (ed). London: Routledge.
33
34
35 452 Harvey MG and Novicevic MN (2002) The hypercompetitive global marketplace: the
36
37 453 importance of intuition and creativity in expatriate managers. *Journal of World Business*
38
39 454 37: 127-138.
40
41
42 455 Haverkort B (2010) The inter-university initiative CAPTURED: Bridging worldviews, ways
43
44 456 of learning and ways of knowing. *Journal of Ayurveda and Integrative Medicine* 1: 56-62.
45
46 457 HMI (Holistic Management International) (2013) Holistic Management Whole Farm/Ranch
47
48 458 Planning System. [https://holisticmanagement.org/wp-content/uploads/2013/02/HM-](https://holisticmanagement.org/wp-content/uploads/2013/02/HM-System-Highlights.a.pdf)
49
50 459 [System-Highlights.a.pdf](https://holisticmanagement.org/wp-content/uploads/2013/02/HM-System-Highlights.a.pdf). Accessed 15 November 2018.
51
52
53 460 Hochman Z and Carberry PS (2011) Emerging consensus on desirable characteristics of tools
54
55 461 to support farmers' management of climate risk in Australia. *Agricultural Systems* 104:
56
57 462 441–450.
58
59
60

- 1
2
3 463 Hodgkinson GP, Langan-Fox J, and Sadler-Smith E (2008) Intuition: A fundamental bridging
4
5 464 construct in the behavioural sciences. *British Journal of Psychology* 99: 1–27.
6
7 465 IAASTD (International Assessment of Agricultural Knowledge, Science and Technology for
8
9 466 Development). (2009) *Agriculture at a crossroads: A synthesis of the global and sub-*
10
11 467 *global IAASTD reports*, McIntyre BD, Herren HR, Wakhungu J and Watson RT (eds).
12
13 468 Washington, DC: Island Press.
14
15
16 469 Jarvie I, Milford K, Miller D (eds.) (2006) *Karl Popper: A Centenary Assessment Vol III:*
17
18 470 *Science*. Aldershot: Ashgate Publishing.
19
20
21 471 Kahneman D (2003) Maps of bounded rationality: Psychology for behavioral economics.
22
23 472 *American Economic Review* 93: 1449-1475.
24
25
26 473 Khatri N and Ng. HA (2000) The role of intuition in strategic decision making. *Human*
27
28 474 *Relations* 53: 57-86.
29
30 475 Kieft H (2006) Quantum Agriculture: bridging frontline physics and intuitive knowledge of
31
32 476 nature? In: *Moving Worldviews, reshaping sciences, policies and practices for endogenous*
33
34 477 *sustainable development*, Haverkort B and Reijntjes C (eds). Leusden: Compas Leusden.
35
36 478 pp. 209-218.
37
38
39 479 Kieft H (2015) Intuitive farming: Towards a new vision on nature. Proceedings of the XI
40
41 480 International People-Plant Symposium on Diversity: Towards a New Vision on Nature.
42
43 481 *Acta Horticulturae* 1093: 179-194.
44
45
46 482 Kieft H (2019) *Quantum Leaps in Agriculture*. LAP LAMBERT Academic Publishing.
47
48
49 483 Kirksey E and Helmreich S (2010) "The Emergence of Multispecies Ethnography." From the
50
51 484 Editorial Office, Cultural Anthropology website, June 14, 2010.
52
53 485 <https://culanth.org/fieldsights/277-the-emergence-of-multispecies-ethnography>. Accessed
54
55 486 24 September 2017.
56
57
58 487 Knowler D and Bradshaw B (2007) Farmers' adoption of conservation agriculture: A review
59
60 488 and synthesis of recent research. *Food Policy* 32: 25–48.

- 1
2
3 489 Lufityanto G, Donkin C and Pearson J (2016) Measuring intuition: Nonconscious emotional
4
5 490 information boosts decision accuracy and confidence. *Psychological Science* 27: 622–634.
6
7 491 Lunneryd D (2003) Unique decision making with focus on information use. The case of
8
9 492 converting to organic milk production. *Acta Universitatis Agriculturae Suecia; Agraria*
10
11 493 405, SLU, Uppsala, Sweden. (<http://epsilon.slu.se/index.html>).
12
13
14 494 Lynch T, Gregor S and Midmore D (2000) Intelligent support systems in agriculture: how can
15
16 495 we do better? *Australian Journal of Experimental Agriculture* 40: 609–620.
17
18 496 Makondo CC and Thomas DSG (2018) Linking indigenous knowledge with western science
19
20 497 for effective adaptation. *Environmental Science and Policy* 88: 83-91.
21
22
23 498 McCown RL, Carberry PS, Dalglish NP, Foale MA and Hochman Z (2012) Farmers use
24
25 499 intuition to reinvent analytic decision support for managing seasonal climatic variability.
26
27 500 *Agricultural Systems* 106: 33–45.
28
29
30 501 Nonaka I and van Krogh G (2009) Tacit knowledge and knowledge conversion: Controversy
31
32 502 and advancement in organizational knowledge creation theory. *Organization Science* 20:
33
34 503 635-652.
35
36
37 504 Nuthall PL (2012) The intuitive world of farmers – The case of grazing management systems
38
39 505 and experts. *Agricultural Systems* 107: 65–73.
40
41
42 506 Nuthall PL (2013) *The Intuitive Farmer: Inspiring Management Success*. Portland, OR: 5M
43
44 507 Publishing.
45
46 508 Nuthall PL and Old KM (2018) Intuition, the farmers’ primary decision process. A review and
47
48 509 analysis. *Journal of Rural Studies* 58: 28-38.
49
50
51 510 OECD (Organisation for Economic Co-operation and Development) (2012) *Farmer*
52
53 511 *Behaviour, Agricultural Management and Climate Change*. Paris: OECD Publishing.
54
55 512 Öhlmér B (2007) The Need and Design of Computerized Farm Management Tools – Lessons
56
57 513 Learned from a Swedish Case. Working Paper Series 2007:5. Department of Economics,
58
59 514 SLU, Uppsala. (<https://pub.epsilon.slu.se/3027/>).
60

- 1
2
3 515 Öhlmér B, Olson K and Brehmer B (1998) Understanding farmers' decision making processes
4
5 516 and improving managerial assistance. *Agricultural Economics* 18: 273-290.
6
7 517 Parry GA (2005) Native wisdom in a quantum world. *Shift* 9: 29-33.
8
9 518 Paxton R, Klimek M, Vieweger A, Döring T, Bloch R, Bachinger J and Woodward L (2017)
10
11 519 The role of intuition in managing organic farm system health. In: *Innovative Research for*
12
13 520 *Organic 3.0 - Volume 1: Proceedings of the Scientific Track at the Organic World*
14
15 521 *Congress 2017*, Rahmann et al. G (eds) November, 2017, Delhi, India. Thünen Report,
16
17 522 No. 54,1.
18
19 523 Pimbert M (2015) Agroecology as an alternative vision to conventional development and
20
21 524 climate-smart agriculture. *Development* 58: 286–298.
22
23 525 Prokopy LS, Floress K, Klotthor-Weinkauff D and Baumgart-Getz A (2008) Determinants of
24
25 526 agricultural best management practice adoption: Evidence from the literature. *Journal of*
26
27 527 *Soil and Water Conservation September* 63: 300-311.
28
29 528 Robert M, Dury J, Thomas A, Therond O, Sekhar M, Badiger A, Ruiz L and Bergez J-E (2016)
30
31 529 CMFDM: A methodology to guide the design of a conceptual model of farmers' decision-
32
33 530 making processes. *Agricultural Systems* 148: 86–94.
34
35 531 Rosenberg LL (2017) Turi kumwe (we are together): A transdisciplinary exploration of the
36
37 532 Burundian specialty coffee sector and its sustainability challenges. PhD Dissertation.
38
39 533 Stellenbosch University, South Africa.
40
41 534 Sadler-Smith E and Shefy E (2007) Developing intuitive awareness in management education.
42
43 535 *Academy of Management Learning & Education* 6: 186-205.
44
45 536 Salas E, Rosen MA and DiazGranados D (2009) Expertise-based intuition and decision making
46
47 537 in organizations. *Journal of Management* 36: 941-973.
48
49 538 Simaika JP and M Samways M (2018) Insect conservation psychology. *Journal of Insect*
50
51 539 *Conservation* 22: 635-642.
52
53 540 Steiner R (1967) *The Stages of Higher Knowledge*. Hudson: Anthroposophic Press.
54
55
56
57
58
59
60

- 1
2
3 541 Steiner R (1995) *Intuitive Thinking as a Spiritual Path; A Philosophy of Freedom*. Centennial
4
5 542 Edition. Hudson: Anthroposophic Press.
6
7 543 UNCTAD (United Nations Conference on Trade and Development) (2013) Trade
8
9 544 and Environment Review. Wake up before it is too late: Make agriculture truly sustainable
10
11 545 now for food security in a changing climate. United Nations Publication.
12
13 546 (unctad.org/en/PublicationsLibrary/ditcted2012d3_en.pdf).
14
15
16 547 Van Eijk T (1998) *Farming Systems Research and Spirituality*. PhD dissertation. Wageningen
17
18 548 University, the Netherlands.
19
20
21 549 Van Eijk T (2019) *Spinoza in the light of spiritual development*. Lulu.com
22
23 550 Vangala RNK, Hiremath BN and Banerjee A (2014) A theoretical framework for knowledge
24
25 551 management in Indian agricultural organizations. Article 6, In: *Proceedings of the 2014*
26
27 552 *International Conference on Information and Communication Technology for Competitive*
28
29 553 *Strategies*, November 2014, Udaipur, Rajasthan, India.
30
31
32 554 Von Diest SG (2019) Could biodynamics help bridge the gap in developing farmer intuition?
33
34 555 *Open Agriculture* 4: 391-399.
35
36
37 556 Zylstra MJ, Knight AT, Esler KJ and Lesley LLL (2014) Connectedness as a core conservation
38
39 557 concern: An interdisciplinary review of theory and a call for practice. *Springer Science*
40
41 558 *Review* 2: 119–143.
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60