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Craig Galloway
Heidi Prozesky
Beatrice Conradie
Karen Esler

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About the authors:

Craig Galloway is a sustainable agriculture researcher with Trace & Save. He specialises in natural resource stewardship in agricultural production and sustainable farm management systems.
This data is based on his PhD (Stellenbosch University, 2017).

Heidi Prozesky is the research manager at the DST-NRF Centre of Excellence in Scientometrics and Science, Technology and Innovation Policy. Her research specialisations include social research methodology, environmental sociology, and women in science.

Beatrice Conradie is an associate professor in the School of Economics specialising in agricultural economics. She is the director of the Sustainable Societies Unit in the CSSR.

Karen Esler is a full professor and Head of the Department of Conservation Ecology & Entomology. She simultaneously navigates disciplinary depths in ecology to work across disciplines, allowing her to contribute to inter-disciplinary and applied spaces focused on environmental challenges

Perceptions and adoption of sustainable dairy practices in the Eastern Cape

Abstract

To encourage the adoption of sustainable agricultural practices amongst farmers one needs to understand what drives their decision-making processes. This study examined commercial dairy farmers' perceptions of sustainable agriculture and documented their level of adoption of sustainable practices. Sixty-five respondents, a quarter of the dairy farmers in the Eastern Cape, completed the questionnaire. The farmers emphasized economic and environmental aspects of sustainability over its social dimensions. They were overwhelmingly positive about sustainable agriculture and its potential role in ensuring the long-term success of commercial agriculture in South Africa. Levels of adoption of sustainable practices varied, with certain practices widely adopted (e.g. the calculation of fertiliser requirements based on soil tests), some partially adopted (e.g. limiting chemical pesticides), while in the case of others adoption was limited (e.g. waste recycling). Adoption rates were correlated with attitudes to sustainability. These farmers' appreciation of the benefits of sustainable agriculture could be used to motivate them to do more but they face many real and perceived challenges in the process of doing so. More research could make it much easier for them to comply with societal ideals.

1. Introduction

Over the last century agriculture expanded and intensified to meet the dietary needs of an expanding world population (Pretty et al., 2003; IAASTD 2009; Kraatz, 2012; FAO 2013). Productivity growth has often been at the expense of the environment (Sattler et al., 2010; McGuire et al., 2013). To mitigate negative environmental consequences, a sustainable approach is increasingly being advocated by researchers, politicians, business leaders and the public (Hansen, 1996; Ikerd et al., 1998). It is, however, also important to consider the practical

needs of farmers who need to remain profitable while producing enough healthy and nutritious food without causing excessive damage to the environment.

Sustainable agriculture is poorly defined. Terms such as 'sustainable', 'conventional' and 'organic' are widely used without being explicitly defined. 'Conventional' agriculture is often equated to the use of high-technology, high-intensity and high-external-input agricultural systems, and the use of chemical herbicides, pesticides and fertilisers, and genetically modified organisms, in particular (e.g. Pretty, 1997; Deaton & Hoehn, 2005). Framed in terms of its negative environmental impacts, conventional methods are presented as the opposite of sustainable agriculture (Rodriguez et al., 2008), although they can deliver sustainability. The emerging consensus seems to be that sustainable agriculture is more about pursuing triple bottom line goals than about adopting particular methods (Hansen, 1996; Pretty, 1997; Ikerd et al., 1998).

In South Africa approximately 80% of all land is owned by farmers, rendering them, effectively, key custodians of the natural environment (Kotze & Rose, 2015). If greater sustainability is to be promoted it becomes important to understand how they make choices. Farmers may differ in their attitudes, values and understanding of sustainability (Sattler et al., 2010; Bohnet et al., 2011; McGuire et al., 2013; De Villiers et al., 2014; Conradie & Piesse, 2016) and in the end there are business in which the profit motive could be more important than attitudes to the environment (Karali et al., 2013).

Information, knowledge, orientations, beliefs and attitudes all influence the actions of individuals and any one or more of these could therefore facilitate or hinder behavioural change, but all of them combined may not necessarily result in desired behaviour (Godfrey, 2011). The most prominent theory used to determine what influences environmental behaviour, and therefore to predict that behaviour, is Ajzen's (1985) Theory of Planned Behaviour (Godfrey, 2011). This theory states that an individual's intention is influenced by three factors: the individual's attitude towards the behaviour; the subjective norms (as influenced by the perceptions of others and societal and/or cultural pressures); and perceived behavioural control (e.g. time, money, skills, and cooperation of others), which then influences behavioural achievement (Ajzen, 1991). Importantly, an individual's perception of a practice does not necessarily correspond with the extent to which that individual will adopt the practice. Although important, understanding what influences the adoption of sustainable practices on dairy farms can therefore not be reduced merely to understanding farmers' orientations

towards sustainable practices, as such orientations constitute only one of many aspects that may potentially influence behaviour (Ajzen, 1991).

Studies about commercial farmers' perceptions of sustainable agriculture and factors influencing whether farmers act sustainably have been conducted predominantly in North America (e.g. Maybery et al., 2005; Ernst & Wallace, 2008; Rodriguez et al., 2008; Bohnet et al., 2011; McGuire et al., 2013).

Rodriguez et al. (2008) found various barriers to the adoption of sustainable farming practices and emphasise the need to understand why farmers are reluctant to change unsustainable practices (e.g. financial risk and a lack of infrastructure). Bohnet et al. (2011) suggest that farmers' skills, resources, values and motivations drive their perception of the land they manage, and therefore influence the practices they adopt. Economic, environmental and/or social aspirations could also play a role (Greiner et al., 2009). Unfortunately, it is difficult to generalise from these results because farmers' decision making is complex and context specific (Maybery et al., 2005; McGuire et al., 2013; Karali et al., 2014).

South African studies of commercial farmers' perceptions of, and attitudes towards, practices are skewed towards the topic of environmental conservation (e.g. Winter et al., 2005; Winter et al., 2007; Conradie et al., 2013). Limited research has been conducted on commercial farmers' perceptions and adoption of sustainable agriculture in South Africa. Duvel and Botha (1999) examined conservation behaviour and influences on the adoption of conservation practices on extensive-grazing farms in South Africa. De Villiers et al. (2014) studied the differences between land managers that do and do not apply Holistic Management™ principles in extensive grazing areas.

It is not easy to convince farmers to become more sustainable, often because farmers do not fully appreciate the benefits of sustainability (Ikerd et al., 1998). Further research into understanding the perceptions and attitudes of farmers is therefore needed to address their concerns, possible misperceptions and/or lack of understanding of the benefits associated with sustainable agriculture (de Snoo et al., 2013). The following key questions addressed in this study are addressed: a) what are commercial dairy farmers' perceptions of sustainable agriculture; b) what sustainable practices have been adopted; c) do these perceptions and practices relate to each other; and d) do any demographic variables relate to the level of adoption of sustainable practices?

2. Methods

2.1. Research design

A predominantly quantitative research strategy was followed to answer the research questions through the replicable collection of quantitative and quantifiable data, which were analysed statistically to produce generalisable results (Bryman, 2012), although care was taken in this study not to extend the generalisations beyond the limitations set by the sampling design. Some qualitative data were also collected, with the aim of augmenting the quantitative descriptions with a more in-depth understanding of how the respondents interpret their social world (Bryman, 2012). A cross-sectional research design, a survey, was applied. One difficulty with this design (compared to, for example, an experimental design) is that causal relationships are difficult to infer unambiguously (Bryman, 2012). However, it was the design best suited to answer the research questions, as is explained in more detail below.

2.2. Population

This research was conducted in the western part of the Eastern Cape, the largest milk-producing province in South Africa, which contributes 30.6% of the country's milk output (MPO, 2016). The study provides insight to the Woodlands Dairy Sustainability Project (WDSP), an initiative of Woodlands Dairy, a milk processor and manufacturer of dairy products that is situated in Humansdorp in the Eastern Cape. This project is operated by an independent sustainable agriculture company, Trace and Save. The service involves the assessment of on-farm sustainability indicators, and provision of support on which practices to adopt to improve the sustainability of the suppliers' agricultural production systems. Woodlands Dairy has been promoting sustainable dairy-farming practices through the implementation of the WDSP, and through the funding of research, such as this study, to assist the company in developing a better understanding of how to facilitate the adoption of more sustainable practices among farmers that supply the company with milk. Thus, data were collected primarily on farms which were selling milk, at the time of sampling, to Woodlands Dairy. These farms were also chosen because the primary researcher, as an employee of Woodlands Dairy, had easy access to the company's suppliers, which offered practical advantages with regard to the distribution and collection of questionnaires.

These farms are situated in the Tsitsikamma, Oyster Bay, Humansdorp, Alexandria, Cradock and Cookhouse areas, where most of the Eastern Cape's dairy production occurs. In addition, other dairy farmers (defined as farms on which dairy farming is the primary practice) were identified through a dairy study-group and by an agricultural consultant in these same areas and were invited to participate to increase the amount of data collected. The term 'farmer', and therefore the potential respondents, was broadly defined to include owners, managers and share-milkers on identified farms. All of these roles involve significant decision making relevant to the research. On farms where more than one person fulfils these roles, the individual most willing to participate in the study completed the questionnaire. Owners often referred field-workers to managers, and field-workers deferred to the owners in this regard due to the ethical consideration of voluntary participation, and the importance of maintaining good relationships with farmers in the longer term. On farms where more than one individual (i.e. both farm owner and manager) was willing to participate, each completed a questionnaire.

This non-probability sampling method (Bryman, 2012) has limitations, compared with drawing a probability sample from a sampling frame of farms in the areas of interest. The latter was not possible as the researcher, as representative of a specific company in a very competitive environment, would not have access to a sampling frame of all dairy producers in the area. In addition, the notion of 'farmer' as a sampling unit is problematic, as owners, managers and share-milkers (farm managers who share in a percentage of the profits of the farm and receive a basic salary) may be operating alone or in combination, as 'farmers' supplying milk to a single producer. While these limitations are acknowledged, there is no reason to believe that the population selected through non-probability sampling is in any way different from the broader dairy-farming population, and therefore some generalisations to that population may be made.

2.3. Data collection

A self-completion questionnaire was chosen for this study, as data could be collected from a larger number of respondents than face-to-face interviews would have allowed, given the limited time, and potential respondents' literacy levels were considered more than adequate for this method. The questionnaire was only distributed in English, again based on the potential respondents' English literacy levels being considered adequate. The questionnaire format consisted predominantly of closed items with pre-coded responses, resulting in quantitative

data. In certain cases, open-ended questions were posed to provide further insight into respondents' motivations for certain responses to closed-ended items. The questionnaire contained 14 items that took the various forms of personal factual questions, questions about attitudes, questions about beliefs, and informant factual questions (Bryman, 2012). The items were clustered into five sections: 1) perceptions on sustainable agriculture; 2) opinions about sustainable agriculture; 3) adoption of practices; 4) sources of knowledge (results are not, however, reported as they proved irrelevant); and 5) demographic information.

The items were developed specifically for this study, i.e. to apply to the context of the commercial dairy farmers selected for study. However, the choice and formulation of many of the items were informed by previous studies on landowner attitudes and practices relating to conservation and sustainable agriculture (Hansen & Jones, 1996; Cary & Wilkinson, 1997; Rigby et al., 2001; van Calker et al., 2005; Ernst & Wallace, 2008; Campbell et al., 2011; McGuire et al., 2013; Morton et al., 2013). The choice and formulation of items were further informed by the primary researcher's experiential knowledge of commercial dairy farmers. The face validity of the items, and of the entire questionnaire, was maximised through a process of iterative review by the supervisors of the primary researcher, and also by a private consultant with more than 20 years' experience in the dairy-farming industry. In addition, the questionnaire was piloted with two local dairy farmers, who provided feedback on ease of completion, and understanding and applicability of the items. The responses to Section 4 were excluded from the data analysis, as the manner in which the questions were structured did not provide any meaningful insight into the sources of farmers' knowledge.

Respondents were initially approached telephonically or in person, to request their completion of the questionnaire. This process was facilitated by the positive relationship which already existed between Woodlands Dairy and the majority of the respondents. However, the relationship also presented a challenge because farmers had already been asked by Woodlands Dairy to contribute data on a regular basis for the WDSP, and therefore some perceived our request for participation as an additional administrative burden. Most of the refusals to participate (approximately 10 farmers) can be attributed to this factor. As described above, other respondents were approached through a study group or private consultant, which in the latter case also relied on already established relationships. There is potential bias in using this method of approaching participants, as farmers who have not joined such a study group or have not enlisted the services of a private consultant, may not be comparable to their peers

who have done so. As a result, a subset of more progressive farmers may have been selected. This potential bias is, however, addressed to some extent by the fact that the farmers who sell milk to Woodlands Dairy are not limited by this bias. In short, including farmers approached through the study group and by the consultant, ensured that the sample was not limited to farmers who produce milk for Woodlands Dairy, while inclusion of the Woodlands Dairy farmers ensured that not only farmers who participate in study groups or have a consultant were studied.

Each questionnaire was either delivered personally or e-mailed, after an explanation of the research had been offered in person or telephonically. As the questionnaire took only 20–30 minutes to complete, in the case of personally delivered questionnaires by a fieldworker, (see below) they would wait for the respondent to complete the questionnaire (which also ensured that someone was on hand to provide clarity, if necessary, i.e. a supervised self-completion questionnaire), but respondents often asked for the questionnaire to be left with them to be completed at their convenience. Frequently this required two or three follow-up telephone calls, often over a period of two to three months, to ensure the return or collection of the completed questionnaire.

The assistance of colleagues who are employed by the WDSP was enlisted in the distribution of the questionnaires. It should be considered that the respondents were not anonymous to the researcher or other fieldworkers who collected the completed questionnaire from them, and that the respondents knew that the researcher was a member of a project encouraging the adoption of sustainable practices on dairy farms. Some of the results may therefore be prone to social-desirability bias, i.e. respondents may have answered ‘through a filter’ (Babbie & Mouton, 2001:238) of what they perceived the socially desirable responses to be. Such bias was countered as far as possible by means of assurances of confidentiality and anonymity. Before the process of questionnaire distribution was initiated, a briefing was held with the fieldworkers, during which the aims of the study, and other ethical considerations, were communicated to them.

2.4. Ethical considerations

The research posed very limited harm to participants, as the data collected were not sensitive. Potentially personal data were treated as confidential, while the entire dataset was anonymised. All completed questionnaires were stored in a locked cabinet, and electronic data were stored on a secure cloud drive. An

informed-consent form was signed by each respondent before completing the questionnaire.

Some respondents were concerned about providing data to a Woodlands Dairy employee and so it was decided that none of the data would be made available to the company even in anonymised form. The company received only the analysis, results and discussion contained in this paper. Prior to data collection, ethical clearance was obtained from Stellenbosch University's Research Ethics Committee for Human Research in the Humanities (DESC/Galloway/ Sep2014/19) and during the interview the purpose of the research was clearly stated and informed-consent was obtained in writing.

2.5. Data processing and analysis

The responses to the questionnaire items were entered into Microsoft Excel, in the form of codes for closed-ended items, and text for open-ended questions. A thematic analysis of the latter was performed to identify main themes in the responses, which were then coded, thereby quantifying those qualitative data.

It should be noted that a number of sustainable practices were not considered in the survey. Irrigation scheduling and the use of moisture probes to observe soil moisture levels in irrigated lands were excluded, as the large number of dryland farms included in the study rendered these practices non-applicable to many of the respondents. Practices such as the application of compost tea on soils and the installation of heat-exchange systems to save energy in the dairy were not included, as the responses indicated that these practices were not well understood by the respondents. The installation of solar geysers was excluded as this had been done on many farms by ESKOM, and therefore was not considered a reliable indication of farm management.

Both descriptive (univariate) analysis and bivariate analysis (to examine relationships between sets of relevant variables, i.e. perceptions and practices; and demographic variables and level of adoption of practices) were performed, using Microsoft Excel. Where applicable, a Pearson Chi-Square test was conducted in IBM SPSS Statistics 24 to test for association among variables of nominal data. Sometimes it was deemed appropriate to reduce the number of categories of variables by collapsing those responses indicating various levels of agreement or disagreement into the more general categories 'agree' or 'disagree'. Further data processing involved creating a composite variable, labelled

‘orientation towards sustainable agriculture’, by adding, for each respondent, the codes assigned to their responses (1: strongly disagree; 2: disagree; 3: neutral; 4: agree; 5: strongly agree) to each statement that measured attitudes, beliefs and perceptions about sustainable agriculture. The calculation assumes equal importance of each orientation, as no weighting was done. Two categories of the composite variable were then created: a negative orientation towards sustainable agriculture (below the median), and a positive orientation towards sustainable agriculture (above the median).

For items measuring level of adoption of various practices, data reduction involved collapsing a five-point scale into three categories: ‘not adopted’, ‘some adoption’ or ‘adopted’. Furthermore, a composite score of adoption of sustainable practices was calculated by summing the level of adoption, as selected by the respondent on the original scale from 0 (no adoption) to 5 (full adoption) for selected sustainable practices (those that were considered to have relevance to all the dairy farms in the study area). This resulted in a cumulative score, with higher values indicating a greater level of adoption of practices. The calculation again assumes equal importance of each practice, as no weighting was done. The composite variable, level of adoption of practices, was then grouped into two categories: low-level adopters (below the median) and high-level adopters (above the median).

3. Results

3.1. Response rates

Of a possible 82 suppliers to Woodlands Dairy, 51 farmers (62%) responded to the questionnaire, which is considered a good response rate (Babbie & Mouton, 2001). These farms are distributed between the following regions: 16 in the Tsitsikamma; seven in Oyster Bay; eight in Humansdorp; one in Gamtoos; 13 in Alexandria; and six in Cradock and Cookhouse. For two of these farms, both the farm owner and manager responded to the questionnaire. A further 25 commercial dairy farmers were approached from a study group in the Alexandria area, some of which are Woodlands Dairy suppliers, but data were obtained from only five of them. Data from another seven respondents were obtained by approaching them through a private consultant who successfully recruited everyone he approached.

The total of 65 respondents, from 63 farms, represent 25% of the dairy farms in the Eastern Cape. Similar research conducted in Burdekin River catchment, Australia, reported a comparable response rate, which represented 30% of the study area (Greiner et al., 2009). Because the population is relatively homogeneous, it is believed that this sample, although small, provides a fair representation of dairy farmers in the Eastern Cape, especially for an exploratory study such as this one, but caution is advised when generalising from the data to this theoretical population.

3.2. Demographics of respondents

The respondents are a diverse group of individuals in terms of demographic and other background variables. The age of the respondents ranges from 24 to 71, and the arithmetic mean is 44.4 and median is 44. The home language of the majority (two-thirds) of the respondents is Afrikaans, while for the remainder it is English. Although the questionnaire was only provided in English, some Afrikaans respondents answered the open-ended questions in Afrikaans. The majority of the respondents reported a diploma or bachelor's degree as their highest level of education, which in most cases is agriculturally orientated (Table 1). Most of the respondents (n=45) are farm owners, 41 of which live on and actively manage the farm; two are partners in a farm business, but also live on, and actively manage, the farm; and two do not live on, or manage, the farm. Sixteen of the respondents are farm managers and four are share-milkers.

Table 1: Respondents' level and type of education

Education	**Count (n=65)**
Grade 12 or less	18
Bachelors or diploma	40
Postgraduate	7
Agriculturally orientated	40
Not agriculturally orientated	25

Respondents have on average 20 years of experience in owning and/or managing a farm, although this experience ranged extensively, from a minimum of 2 to a maximum of 46 years. The majority of respondents reported having learned

farming, in addition to their formal education, from their parents, in particular their fathers (n=40). This both reflects that dairy farming and farming in general in South Africa is androcentric and is consistent with the result that all but seven respondents cited farming as being 'a part of their culture'. As culture is a complex concept, which changes meaning depending on context (Bandura, 2002), the term was intentionally left undefined in this item, allowing the respondents to ascribe their own meaning to it. In this context we believe respondents are identifying with a set of norms, values and beliefs, and practices and a way of living that can be associated with being a farmer (Stewart & Zaaiman, 2014).

3.3. Perceptions of sustainable agriculture

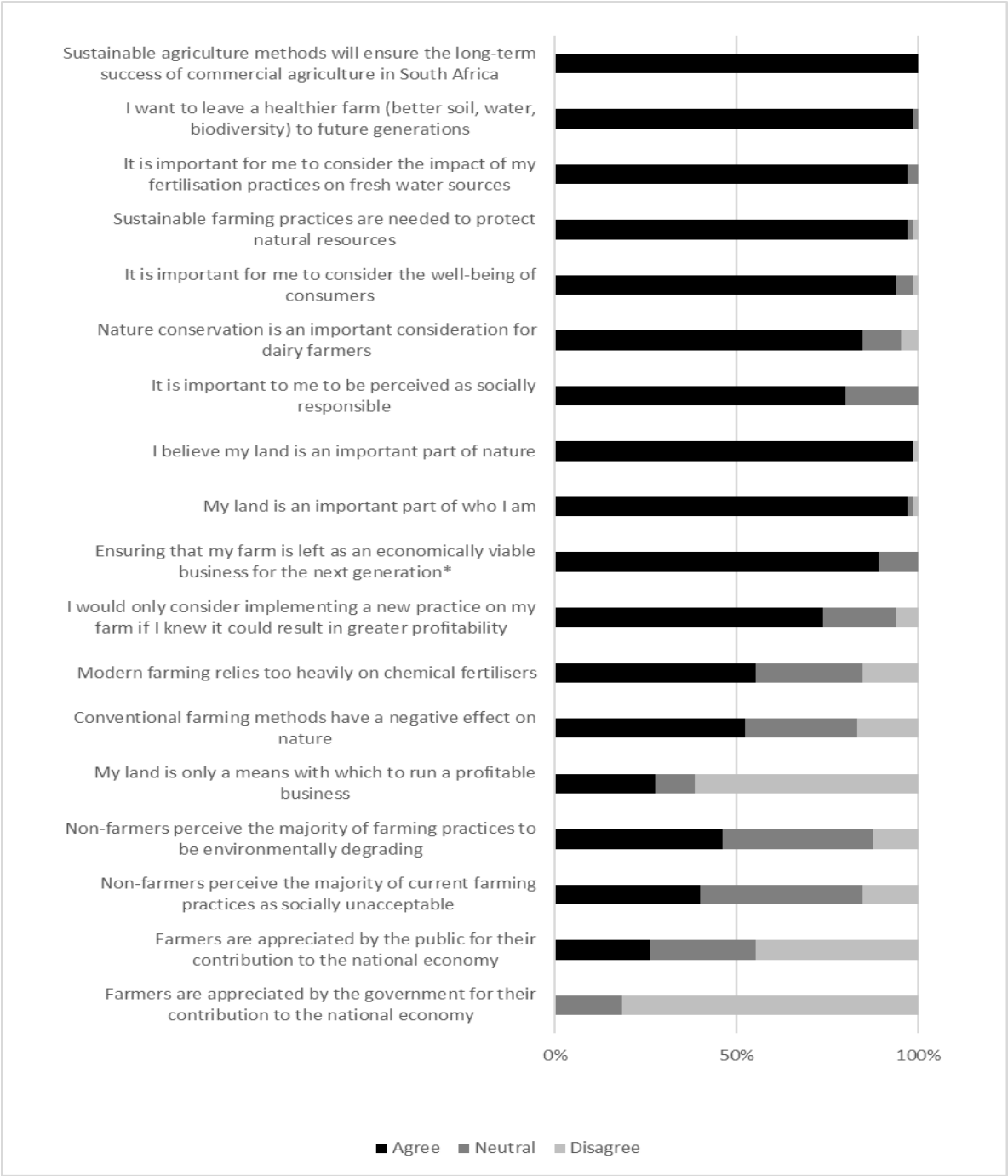
Respondents' own definitions of sustainability (provided in response to an open-ended question, the first one in the questionnaire) tended to focus more readily on its economic and environmental dimensions, than on its social ones (Table 2). Also, in these definitions, strong emphasis is placed on long-term success and future generations.

In response to a number of closed-ended items, all of the respondents believed that it is beneficial to implement sustainable agricultural practices on their farms. All respondents also agreed that the economic aspect of triple bottom line sustainability is important in managing a farm, and nearly all (with one exception) agreed about the importance of its environmental aspect. Less consensus emerged regarding the importance of its social aspect. No respondents viewed any of the three aspects of triple bottom line sustainability as unimportant, but social-desirability bias should be taken into account when interpreting these results. These findings do, however, support the respondents' own definitions of sustainability (Table 2).

Table 2: Dimensions of respondents' definition of sustainable agriculture in response to an open-ended question asking them to define sustainable agriculture in their own words

Themes	**Frequency**	**Percentage**
Environment (e.g. limit impact, natural resources, nature, soil)	44	33
Future (e.g. future generations, long-term)	41	30
Economic (e.g. efficiency, finances, production, productive, profit)	41	30
Social (e.g. food security, society)	4	3
Other - positive (e.g. balance, growth, measurement, support)	4	3
Other - negative (government interference)	1	1
Total	**135**	**100**

Respondents appeared to largely agree with various statements about sustainable agriculture and related issues (Figure 1). Almost all respondents agreed that sustainable agriculture methods will ensure the long-term success of commercial agriculture in South Africa, and they also expressed a desire to leave their farms in a healthier condition for future generations (Figure 1), showing an appreciation among respondents that these are ideals to be strived for. Most respondents also viewed it as important to consider the well-being of consumers and reported that nature conservation is an important consideration for dairy farmers, thereby acknowledging the role of farmers to produce food in a manner that limits environmental impact.



**Full statement: Ensuring that my farm is left as an economically viable business for the next generation of farmers is an important motivating factor in how I make management decisions*

Figure 1: Respondents' orientation towards sustainable agriculture, opinions on issues related to sustainable agriculture, opinions on how non-farmers perceive farming practices, and perceptions of level of government and public appreciation for farmers (n=65).

Most respondents would only consider implementing new practices if they knew it would result in greater profitability (Figure 1), indicating that economic considerations play a strong role in farmers' decision-making processes regarding the adoption of new practices. This does not, however, apply unequivocally to all farmers: one respondent commented that he 'would implement (a practice) if it was for the same profit, but better for the environment', and another reported, 'I would consider implementing an environmentally beneficial practice in my business if it didn't have a significant financial detriment'. Another provided the following insightful comment: 'Sometimes one needs to experiment without knowing exactly what the outcome will be. In addition, some actions have an indirect financial benefit, e.g. good labour housing could contribute to staff morale and thus conscientiousness'.

Respondents varied in terms of how they think non-farmers perceive current farming practices (Figure 1). Most farmers believed that the public and government do not appreciate their contribution to the economy of South Africa (Figure 1). Some related, primarily cautionary, comments were made by respondents. One said: 'long-term success of commercial agriculture could be negatively impacted severely by the possible political future of our country'. Another respondent expressed concern that land-reform projects are being implemented without the necessary capital and expertise, which will not result in sustainable agriculture. Yet another related comment was: 'We have to aim to develop much, much better relationships between farmers, the government and workers on our farms. Relationships are everything in life. Force farmers less and more will happen'.

3.4. Adoption of sustainable practices

The most widely adopted sustainability practice is the calculation of fertiliser requirements based on soil-fertility testing (Figure 1), which may be a function of most respondents' involvement with the WDSP, but it is also a widely recognised and adopted practice among dairy farmers in South Africa (P. Terblanche 2016, personal communication, 1 June). Not tilling the soil, the spreading of manure/slurry onto pastures, and the measuring of pasture growth have also been adopted by most respondents. The measurement of pastures is considered a sustainable practice as it is integral to basing the implementation of rotational grazing management and pasture allocation on actual measures rather than guestimates, which is a sustainable practice. The measurement of pasture growth was used as a proxy of grazing management. Not adopting the

measurement of pasture growth was explained by one respondent as follows: ‘I have been on this farm for 25 years, know my camp sizes, group sizes, track fertiliser dates and [do] weekly pasture drives’; while another said that ‘your eyes are the best measuring tool’.

The setting aside of natural areas for conservation purposes has not been widely adopted on these farms. Some of the reasons given for this by respondents are that the ‘farm is fully developed’, it is ‘impractical, as all the land is used for production’, ‘land [is] too expensive’, and dairy farming on pastures is intensive agriculture. Where some natural areas have been set aside for conservation purposes, the production value of land is still an important consideration. For example, farmers would set aside the areas that have ‘too many rocks to work’, only the ‘kloofs [gullies] and hills’, or only the ‘non-arable land is kept natural’. It should be noted that there are respondents for whom the setting aside of natural land for conservation purposes is important, ‘to leave some habitat for game and hopefully counter some GHG [greenhouse-gas] effects’, and ‘to maintain wildlife and indigenous plant life’.

Adoption of the non-use of chemical pesticides has been variable. On the one hand, the use of chemical pesticides is justified by the perception that one ‘can't control pests any other way’, or by the practice to ‘try and use as little as possible, but sometimes it is necessary’; alternatively, avoidance of chemical herbicides is motivated on the grounds that it is ‘not good for nature’ and ‘spraying kills good and bad’, a recognition that leads to the use of organic products. Seven respondents specifically mentioned the need to use chemical pesticides to control army worms (*Spodoptera exempta*), which often infest pastures.

Most respondents (adopted: n=25; some adoption: n=27) have adopted, at least partially, the practice of reducing their chemical nitrogen fertiliser use, operationalised as less than 200kg per hectare per year. This is an amount used by Trace & Save (P. Terblanche 2016, personal communication, 1 June), believed (on the basis of agricultural extension research in New Zealand and informal research conducted in the study area) to be optimal for pasture production, soil health and reduced environmental impact. However, two opposing perspectives on this practice emerged in the comments. On the one hand, reasons for reduction in such fertiliser use include causing ‘less damage to microorganisms’ in the soil; facilitating the growth of biological organisms in the soil; and because ‘the cows put a lot of N back into the soil through their dung’. Alternatively, there are those who believe that large quantities of nitrogen

fertiliser are essential to sufficient pasture and therefore milk production, or that they ‘need grass’ which ‘can't grow without N’, and the ‘production pressure’ results in them needing to use more nitrogen fertiliser. This difference in perspectives reflects what some dairy-farming consultants (P. Terblanche 2016, personal communication, 1 June) consider to be a distinction between current practices and sustainable goals of fertiliser-management practices.

Practices which have not been widely adopted by the respondents are the measurement of water use in dairy parlours; the planting of multiple plant species (more than four per pasture); the application of compost on soils; recycling of waste; and the non-use of chemical herbicides. Although compost application is also one of the less widely adopted practices, the respondents’ comments indicate that this is not because of a negative orientation towards the practice, but rather on account of limited compost availability. The use of chemical herbicide appears to be associated with the need to control weeds in a situation where alternatives were perceived as lacking. There were some positive comments about the benefits of multi-species pastures, for example, ‘mixed pastures allow for better growth and feed availability all year round’. A respondent also commented that they had ‘been encouraged to (plant multi-species pastures) by people’, possibly referring to a strong promotion of multi-species pastures by consultants (P. Terblanche 2016, personal communication, 1 June). These positive comments were outnumbered by negative comments about lack of benefits (e.g. respondents considering it as unnecessary, or that ‘two plant species [have been] proven to be successful’); additional costs (e.g. that it takes ‘too much extra effort, financially and mechanically’); and difficulty of planting associated with such pastures. Recycling of waste has not been widely adopted, because respondents tend to perceive it as impractical and unfeasible.

It is notable that the behavioural achievement of sustainable practices is not always consistent with the intention to implement practices. Twenty-five respondents expressed such inconsistency in relation to at least one of the practices in comments such as, ‘it is my goal, but I am not there yet’; it is ‘not always possible’ to implement that sustainable practice; ‘I don’t have an affordable source of compost’, and it is ‘not viable to do it on my own’. These comments show that the respondents recognise the benefit, and would adopt the practices they refer to, were it not for constraining factors they perceive to be external to their locus of control.

3.5. Relationship between respondents' orientations and their adoption of sustainable practices

Among the respondents whose adoption of sustainable practices is above average, a proportionately much larger percentage have a positive than a negative orientation towards sustainable agriculture (Table 3) (Pearson Chi-Square = 5.540, p = 0.019). Because of the inevitable ambiguity of causality associated with the survey design (Bryman, 2012), it is possible that farmers who had already adopted sustainable practices are more positive towards sustainable agriculture, as they have benefited directly from the adoption of these practices. However, according to the theoretical literature reviewed in the introduction of this paper (e.g. Ajzen, 1991), orientation tends to precede behaviour, rather than vice versa. Orientation is therefore treated as the independent variable in Table 3, which is interpreted as showing that the more positively a farmer is oriented towards sustainable agriculture, the more likely he or she is to adopt sustainable practices.

Table 3: Relationship between respondents' orientation towards sustainable agriculture and the adoption of sustainable practices

Level of adoption	**Orientation towards sustainable agriculture**	
	Negative	***Positive***
Low	20 (63%)	11 (33%)
High	12 (37%)	22 (67%)
Total	32 (100%)	33 (100%)

3.6. Relationship between demographic variables and the adoption of sustainable practices

Farmers whose adoption of sustainable practices is below average tend to be Afrikaans rather than English, older rather than younger, and are less likely to have a tertiary qualification (diploma, bachelor's degree or postgraduate degree). It therefore follows that younger, English-speaking farmers with a tertiary education are more likely to adopt sustainable practices. Although some patterns are observed in the data, showing relationships between some demographic features of respondents and their level of adoption of a range of sustainable practices, none of these are significant (Table 4).

Table 4: Relationship between demographic variables and the adoption of sustainable practices

	Language		**Age**		**Level of education**		
Level of adoption	***Afrikaans***	***English***	***24-43***	***44-71***	***Grade 12 or less***	***Bachelor's degree or Diploma***	***Post-graduate***
Low	22 (51%)	9 (41%)	13 (42%)	18 (53%)	10 (56%)	18 (45%)	3 (43%)
High	21 (49%)	13 (59%)	18 (58%)	16 (47%)	8 (44%)	22 (55%)	4 (57%)
Pearson Chi-Square	0.613		0.787		0.617		

*** p ≤ 0.01 and * p ≤ 0.05*

4. Discussion

The purpose of this research is to contribute to the understanding of what motivates farmers' decision making, specifically in relation to the adoption of sustainable agricultural practices. Much research has been performed in an attempt to understand sustainability-related decisions and management on farms (Rodriguez et al., 2008; McGuire et al., 2013). Many factors have been identified as influencing decision making, but the results of different studies are often contradictory. This suggests that seeking widely generalisable results is less productive than focusing on context-specific cases to produce relevant research that would assist in informing those individuals tasked with encouraging farmers within that context towards the adoption of more sustainable agricultural practices (Karali et al., 2014).

In this study, farmers consider agriculture as being part of their culture, which is associated with them having predominantly learned farming from their fathers. Thus, the meaning of farming transcends being merely a livelihood or a business. This results in a complex dynamic, as the practices adopted on a farm are influenced by factors extending far beyond those directly benefitting the farming business. Conradie and Piesse (2016) also found this dynamic of farms passing from generation to generation influencing how farmers perceive risks in the Karoo, South Africa. Further, all of the farmers in this study are Afrikaans and English South Africans, thus the high incidence of transference of farming skills from one generation to the next raises a concern that emerging (especially

black) farmers in South Africa (Rother et al., 2008) might be at a major disadvantage, as they have not benefited from having been socialised in the context of commercial farming. Young people growing up on a commercial farm learn the family business, receiving considerable (additional) training in how to become a successful farmer, as their fathers were before them. In the South African context, where emerging (especially black) farmers did not receive this training, they start their farming careers at a decided disadvantage. This is an issue that should be acknowledged and addressed in the process of encouraging previously disadvantaged, emerging farmers towards sustainable practices.

4.1. Perceptions of sustainable agriculture

Based on their responses to an open-ended question asking them to define sustainable agriculture, and on their scoring of the importance of each dimension to their farm management, the farmers in this study appear to have a clear understanding of what sustainable agriculture is, although they tend to focus more strongly on the environmental and economic dimensions of the construct, than on its social aspects. The salience of the economic dimension is not surprising, as agriculture is primarily a business, and therefore finances play a significant role in farmers' decision making (Conradie et al., 2013). The importance of environmental conservation appears to have been well communicated to farmers (e.g. by consultants, at conferences and in the media), but perhaps more focus should be placed on communicating, and advocating for, the social benefits of sustainable agricultural practices. Although social-desirability may have biased the results slightly towards positive orientations, the challenge of changing negative perceptions of sustainable agriculture, and the need to strongly advocate in favour of sustainable agriculture, seem to have been sufficiently addressed, at least in the field of agriculture and area studied. Efforts should now be directed at better understanding the challenges and limitations associated with the adoption of sustainable practices.

Sustainability requires that a business remains profitable over the long term (Hansen, 1996; Ikerd et al., 1998). The farmers placed a strong emphasis on the long-term aspect of sustainability. Most of them also noted they would only adopt a new practice if it would result in greater profitability, but some acknowledged that this is not a straightforward process. While some practices may incur costs in the short term, they are perceived as resulting in long-term cost saving. In order to address this issue, it is important for those encouraging

the adoption of sustainable practices to highlight the potential of those practices to contribute to the long-term success of the business, even if they involve additional initial costs, in comparison to current practices.

4.2. Perceptions of government

It was clear that the farmers in this study generally do not feel appreciated by the government for their contribution to the national economy. The majority of commercial farms in South Africa are still white owned – a legacy of South Africa's history of apartheid – while an explicit goal of the African National Congress (ANC, the ruling political party in South Africa since the end of apartheid in 1994) government is to redistribute farmland to black ownership (Walker, 2005). This results in white farmers believing that the government is not acting in their best interest and is not appreciative of their role in South Africa (Stewart & Zaaiman, 2014; Kotze & Rose, 2015). This perception may also be linked to farmers' strong association of farming with their culture. The ANC government's agenda of land redistribution and restitution [referred to as 'land reform' (Walker, 2005)], which implies that land would be appropriated from white farmers, poses not only a threat to their livelihood, but also to their culture or way of life. AgriSA (http://www.agrisa.co.za/), an agricultural industry association which represents white commercial farmers in South Africa, has opposed the fragmentation of large, commercial farms through land redistribution, based on the argument that commercial farms maintain South Africa's agricultural productivity.

This is a complex issue, and its complexity is magnified by the lack of clarity in government policy and proposals, which do not always coincide with the implementation of land reform (Lyne, 2014; la Marque, 2015). The slow process of land reform (Walker, 2005; Stewart & Zaaiman, 2014) indicates reluctance by the government to rashly undertake reform that is likely to negatively impact the national economy. Nevertheless, farmers still appear to be opposed to land reform. The evidence collected in this study points to a strained relationship between farmers and the government, which may limit the potential of farmers collaborating with government in landscape-level management projects aimed at achieving sustainable-agriculture goals. Land reform in South Africa should extend beyond simply changing land ownership: it needs to be incorporated into a much broader process of political and socio-economic change in South Africa (Du Toit, 2013). A major aspect of progressive land reform is developing sustainable agriculture that will support the economy, protect the environment,

and achieve societal goals, such as addressing poverty and unemployment, and creating opportunities for emerging farmers and farm workers (Atkinson, 2007; Middelberg, 2013).

farmers were unsure whether the public perceived farming practices as socially unacceptable and environmentally degrading, but almost as many agreed that these perceptions exist. Thus, not only do farmers perceive themselves as unappreciated by the government, but also disapproved of by the public. It is unclear what exactly drives this perception, but farmers seem to believe that the public does not fully understand their context. This has also been expressed by farmers, on numerous occasions, in informal conversations with the author. Such perceptions are likely to limit farmers' willingness to trust, and therefore partner with, role players in the public domain. When contrasted with the farmers' perceptions of themselves as custodians of the land, it is notable that farmers do not believe the public necessarily views them in this manner. This, along with farmers' relative neglect of the social aspects of sustainability in their conceptions thereof, seems to indicate a lack of direct impacts of farm practices on consumers and vice versa.

4.3. Adoption of sustainable practices

This study focuses strongly on those sustainable practices which positively influence soil health, as soil health underpins productive pasture-based dairy farms (Swanepoel et al., 2014). Because of this focus, some practices that may be considered important sustainable management practices on pasture-based dairy farms were not included, for example, monitoring nutrient levels in dairy effluent and the use of phosphate fertiliser. The sustainable practices focussed on in this study have been relatively widely adopted. Interestingly, practices such as not tilling the soil are considered by the agricultural sector as progressive and non-conventional. The wide adoption of no/minimal till practices in this study indicates a shift towards this becoming the conventional practice on pasture-based dairy farms. The same applies to fertiliser application rates calculated from soil testing and the allocation of pastures according to nutritional requirements. These are practices which can significantly contribute to the efficiency of pasture utilisation on dairy farms (Chapman et al., 2011; Fariña et al., 2011; P. Terblanche 2016, personal communication, 1 June), and it is encouraging to see that they have been so widely adopted on the farms in this study.

However, if these practices are so obviously beneficial to the farmer, and contribute to lowering the environmental impact of dairy farming, why have they not yet been fully adopted by all farmers? The qualitative data, and anecdotal evidence collected during conversations between the author and dairy farmers that have not adopted these practices, point towards the persistence of perceptions that the benefits are not worth the effort (e.g. measuring pasture growth involves considerable time and effort on the part of the farmer) and that current practices are sufficient. This supports other research which also found that the perceived costs versus benefits associated with changing practices is a key factor influencing farmers' adoption of new management practices in general (Bohnet et al., 2011).

As noted earlier, orientation is only one aspect of behaviour (Ajzen, 1991) and cannot, therefore, be the sole predictor of the adoption of sustainable practices. In addition, it should also be recognised that the adoption of sustainable practices that have benefitted farmers may have led to a more positive orientation towards sustainability. Orientation does, however, tend to underlie, and therefore provides interesting insights into, the adoption of behaviour (Petrzelka et al., 1996; Maybery et al., 2005; Burton et al., 2008; Godfrey, 2011; Karali et al., 2013; McGuire et al., 2013). A relationship between orientation and adoption of sustainable practices was found amongst the farmers in this study. Farmers who are more positive about sustainable agriculture, are more likely to adopt sustainable practices. For practitioners encouraging the implementation of sustainable agriculture this implies that they should address negative orientations of farmers before explaining and prescribing adoption of practices. Many farmers do not yet perceive these practices to be beneficial to their farming concern, which also needs to be addressed. The assumption cannot be made that farmers necessarily agree with the widely accepted belief (e.g. of consultants and researchers) that these practices assist in achieving sustainability goals. This study shows that farmers indeed perceive sustainable agriculture in strongly positive terms, but this does not necessarily translate into a positive perception of all of the individual sustainability practices considered in this study.

Financial constraints result in a perceived lack of behavioural control (Ajzen, 1991) which negatively affects behavioural achievement. In numerous cases, as shown in the qualitative data, farmers expressed a desire to adopt a practice, but assessed it as unaffordable. Market-based mechanisms to encourage the adoption of practices which aim to achieve sustainability goals are dynamic, in that they respond quickly to changes in supply and demand (de Snoo et al.,

2013) and will help to address this perceived lack of control due to financial constraints. How such a mechanism would be designed and implemented is another challenge that requires further research.

None of the demographic characteristics measured were found to be strong predictors of the adoption of sustainable practices. Previous research has shown relationships to exist between such characteristics and the adoption of environmentally friendly practices (e.g. Conradie et al., 2013; de Villiers et al., 2014; Pérez Urdiales et al., 2015). This study's findings are, however, consistent with other research that shows a weak relationship between demographic factors and the adoption of environmental farming practices (Knowler & Bradshaw, 2007; Ahnström et al., 2008). There could very well be other factors, such as income or farm size, which have an influence on the adoption of practices, but these were not included in the survey, and should be included in future research.

5. Conclusion

Understanding the motivations that underlie individuals' actions is challenging, as these motivations are highly complex. This study contributes to an extensive body of research conducted in an attempt to understand what motivates farmers' decision making on their land. This is a topic of great importance, as farmers are primary land-managers, and the management practices they adopt have a direct impact on the health of ecosystems. Sustainable agriculture and conservation goals require farmers to adopt management practices which conserve and/or improve the health of these ecosystems. The results of this study show that orientation towards sustainable agriculture is linked to adoption of sustainable practices. The emphasis by practitioners encouraging the implementation of sustainable agriculture on the benefits and importance of sustainable practices to farmers, can therefore facilitate adoption. However, in doing so it is equally important to recognise that farmers face many challenges in adopting new practices. The most significant challenges appear to be financial constraints, and the perception that some of the sustainable practices are not actually beneficial. Support should therefore be provided to farmers in their endeavour to improve the sustainability of their agricultural practices. This support should focus on evidence-based knowledge and expertise which can address perceptions that sustainable practices are not worth the effort, thereby carrying out and providing research to farmers which shows and supports the benefits of implementing sustainable agricultural practices. The possibility of providing subsidies and/or tax incentives for the implementation of sustainable practices should also be considered, as a mechanism to overcome financial constraints.

The farmers included in this study represent a significant proportion of the dairy farmers in the Eastern Cape, but the extent to which the results may be generalized to a wider population is limited, as has been discussed in detail. Taking these limitations into account, the results still identify an opportunity for policy makers and government departments which have been mandated to facilitate the implementation of sustainable agriculture in South Africa. There is an obvious disconnect between government and farmers which needs to be addressed before any collaborative progress is made, but farmers are positive about, and therefore open to, sustainable agriculture.

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