Education for sustainable agriculture: the old and new curricula for agricultural sciences in South African schools

Moraig Peden

Abstract

This article explores the support given to Education for Sustainable Agriculture (ESA) by the South African Agricultural Sciences school curricula. It compares two post-apartheid curricula: the current Curriculum Assessment Policy Statements (CAPS) and the phased-out National Curriculum Statement (NCS) for Agricultural Sciences in terms of content, knowledge requirements, cognitive processes and philosophies of education for sustainable agriculture, as well as the role of assessment and the stated purpose of the curricula. While the NCS had a vision of sustainable agriculture and of a progressive curriculum, these aims were not supported in the detail of the curriculum. The CAPS presents a shift back to more traditional, discipline-based agriculture, with a detailed curriculum, which provides more support for ESA in terms of fundamental ecological knowledge as well as sustainable agriculture strategies. However, the CAPS, has fewer requirements for practical agriculture, higher order learning and engagement with broad socio-economic issues. The paper concludes with recommendations for supporting ESA, through teacher education and amendments to the assessment requirements.

Introduction

Environmentally sustainable agriculture is crucial for both future production as well as for the broader environment. The twenty-first century faces threats to global food supplies (*New Agriculturist*, 2008) linked to environmental degradation (Food and Agriculture Organisation of the United Nations [FAO], 2011, 2012). Industrial agriculture, based on fossil fuels has contributed significantly to climate change (Sachs, 2010; International Assessment of Agricultural Knowledge, Science and Technology for Development [IAASTD], 2009), water and soil pollution, the lowering of water-tables, salinization of land (Halweil, 2002) and the loss of biodiversity (Halweil, 2002; The World Bank, 2008; IAASTD, 2009). These costs have been externalised in the drive for high yields, profit and low food prices (Miller, 2000; Halweil, 2002;). 'Business as usual' i.e. industrial agricultural damages

the resource base on which it depends. In South Africa, industrial agriculture is the default approach, of the state Department of Agriculture (DOA) (National Planning Commission [NPC], 2011). With 82% of the land classified agricultural in 2009 (Index Mundi, undated), environmental degradation such as habitat loss and water pollution is being caused by agricultural intensification (Department of Environmental Affairs [DEAT], 2006).

This paper explores whether the South African school curriculum is engaging with Education for Sustainable Agriculture (ESA) as we enter our third decade of democracy.

In order to probe the question further, I analyse and compare the two post-apartheid Agricultural Sciences curricula: the current Curriculum Assessment Policy Statements (CAPS) (Department of Basic Education [DBE], 2011b) and the phased-out National Curriculum Statement (NCS) (Department of Education [DOE], 2003; 2008a; 2008b) for Agricultural Sciences in terms of the content, knowledge requirements and cognitive processes, philosophies of education for sustainable agriculture and the role of assessment and the stated purpose of the curricula.

I ask the following questions:

1. To what extent does the content of the NCS (DOE, 2003; 2008a; 2008b) and the CAPS (DBE, 2011b) support sustainable agriculture as opposed to industrial agriculture?

2. To what extent are the knowledge and cognitive processes in the NCS (DOE, 2003; 2008A; 2008B) and the CAPS (DBE, 2011b) aligned to the philosophies underpinning ESA?

3. To what extent are the stated purposes and assessment of the NCS (DOE, 2003; 2008A; 2008B) and the CAPS (DBE, 2011B) aligned to sustainable agriculture and the philosophies underpinning ESA?

I find that the NCS (DOE, 2003; 2008a; 2008b) had a vision of sustainable agriculture and a progressive curriculum (learner-centred and experiential), which aligned it to philosophies of ESA, but these aims were not supported in the details of the curriculum. The CAPS (DBE, 2011b) presents a shift back to a more traditional, teacher-centred curriculum with a focus on knowledge

transmission within traditional agricultural disciplines. However the CAPS (DBE, 2011b) curriculum is more detailed, providing fundamental ecological knowledge as well as sustainable agriculture strategies which support ESA. On the other hand, the CAPS (DBE, 2011b) has fewer requirements for both practical agriculture and higher order learning (based on progressive pedagogies) and less engagement with broad socio-economic issues. The paper concludes that the CAPS (DBE, 2011b) allows for progressive education for sustainable agriculture although it does not require it. This leads to recommendations for supporting ESA through teacher education and amendments to the assessment requirements.

Sustainable agriculture: a response to industrial agriculture

Industrial agriculture aims for the highest economic yields and maximum profit. It's underlying principles are simplification of ecosystems and large scale production in order to achieve greater efficiency. The farmer is not held responsible for social and environmental impacts beyond the farm boundary. High inputs are required, including mechanisation, petrochemical-based fertilisers and pesticides and hybrid or genetically modified seed. Strategies include intensive animal production and monoculture (Dumanski, Peiretti, Benites, McGarry and Pieri, 2006; Scherr and McNeely, 2008).

Sustainable agriculture emerged in the 1980s in response to concerns about industrial agriculture. The concept is contested. It ranges from weak to strong sustainable agriculture depending on the level of challenge to industrial agriculture. Strong sustainable agriculture aims to transform the broad agri-food system while weak sustainable agriculture attempts to modify but not replace industrial agriculture. Objectives include minimising agricultural pollution and resource depletion, reducing energy use and conservation of soil, water and biodiversity including natural habitats (Reganold, Papendick and Parr, 1990; Pretty, 1995) as well as engaging in an interdisciplinary way with alternatives to the global capitalist food system (Francis, 2005; Wezel, Bellon, Dore, Francis, Vallod and David, 2009).

Sustainable agriculture methods could increase production at the same time as protecting natural resources (IAASTD, 2009; Tirado, 2009). With 82% of land classified agricultural in South Africa in 2009 (Index Mundi, undated),

farmers could play a significant role in conserving the environment through sustainable practices (McNeely and Scherr, 2003; The World Bank, 2008; IAASTD, 2009). National policies in South Africa (DOA, 2008b, 2005a, (Department of Agriculture, Forestry and Fisheries [DAFF], 2011; NPC, 2011) recognise the need to move towards sustainable agriculture within a low carbon-economy. Education is critical in this process (Department of Environmental Affairs [DEA], 2010; NPC, 2011).

Agriculture and sustainability in South Africa

South African agriculture is characterised by 'two agricultures', a legacy of apartheid. White commercial agriculture was strongly supported by the state with research, subsidies, markets and education. Black subsistence agriculture, where farmers produce for their own household needs only, was practised on crowded, marginal land with little support and low productivity (Van Rooyen, Barnard and Van Zyl, 1996). Little has changed under democratic rule. In 2007 commercial farms produced 95% of agricultural output, occupying 87% of agricultural land but comprising only 20% of farmers (DOA, 2008b). Four million subsistence farmers move in and out of agriculture as other income sources fluctuate (Aliber and Hart, 2009).

In recent decades declining farmer numbers have caused declining per capita production and South Africa has become a net importer of food (Dugmore, 2008; Baiphethi and Jacobs, 2009). The National Planning Commission (NPC) of 2011 sees economic growth potential in the agricultural sector and proposes improved support and training for commercial and subsistence farmers.

Land-use practice is a key driver of environmental degradation. In South Africa industrial agriculture is a major water user as well as contributing to water pollution through chemical and effluent run-off. These issues affect river, estuarine and marine ecosystems. Nearly 20% of the natural habitat has been destroyed, mainly for crops and 65% of wetlands are endangered or vulnerable (DEAT, 2006; South African National Biodiversity Institute (SANBI), 2013).

Support for sustainable agriculture comes mainly from the private sector with programmes such as the SusFarMS (Sustainable Sugarcane Farm

Management System) and the Biodiversity and Wine Initiative. State support for sustainable agriculture has been weak. The Biodiversity Stewardship South Africa programme run by the state was initiated by NGOs (KZN Wildlife, n.d.). South Africa has no legal Organic Standards (SAOSO, 2014) and no subsidies for organic farmers (Barrow, 2006).

A history of agricultural schooling in SA

Agricultural schooling evolved from rudimentary gardening for blacks in mission schools in the 1800s to colonial schools producing labourers in the 1900s. In the apartheid era 'Gardening' was taught in black primary schools and 'Agriculture' for the black school leavers' certificate. With homeland development, 'Agriculture' became the training for extension officers working in homeland areas (Paterson, 2004).

In 1994, schooling was deracialised and became the domain of one national department. The National Curriculum Statement (NCS) (DOE, 2003; 2008a; 2008b)) was developed by the Department of Education (DOE). Subsequently, its successor, the Department of Basic Education (DBE) developed the Curriculum Assessment Policy Statement (CAPS) (DBE, 2011b) for all school subjects including Agricultural Sciences. From 1994 onwards, the NCS (DOE, 2003; 2008a; 2008b) Agricultural Sciences was only offered in the final three years of school. The subject is mainly offered in rural, state, black secondary schools (Paterson, 2004; DOA 2008a) where learners take Agricultural Sciences as one subject amongst six other non-agricultural subjects. It is also offered in forty-three specialised agricultural schools which also offer two additional agricultural subjects to both black and white learners. The specialised agricultural schools aim to produce commercial farmers and are better-resourced than the state secondary schools. However they comprise only 0.7% of state secondary schools (DBE, 2015; DOA, 2008a) and enrolments are limited by high fees.

There is a lack of consensus around the purpose of Agricultural Sciences in schools both within and between the state departments of Education and Agriculture. The purposes includes "generalist and formative rather than vocational" (DOA, 2008a, p.7), preparing learners for tertiary education, careers in agriculture and self-employment (DAFF, 2011) and the development of practical skills (DOE, 2008a). There is a tension between

learning *about* agriculture and learning to *engage in* agriculture. In 2013 Agricultural Sciences was in the top eleven most popular National Senior Certificate subjects (DBE, 2013). However, it tends to be selected for its perceived easiness rather than students' interest in farming (DOA, 2008a, Paterson, 2004).

The pedagogy of Agricultural Sciences continues to be based on knowledge transmission with little practical work or problem-solving (Paterson, 2004). The lack of resources and skilled educators has not improved in the democratic era (DOA, 2005; South African Agricultural Teaching Association, 2007; DOA, 2008a; DBE, 2009). Agricultural Sciences continues to be associated with a second class apartheid curriculum, exacerbated by the use of agricultural work as punishment (Paterson, 2004). However, in recent years it has gained greater currency in tertiary education with some diploma and degree programmes accepting Agricultural Sciences as an alternative to Life Sciences as an entry requirement (Western Cape Government, 2014; Mangosuthu University of Technoloy (MUT), undated; University of KwaZulu-Natal (UKZN), undated).

In the next section I describe the two post-apartheid curricula: the National Curriculum Statement (NCS) (DOE, 2003; 2008a; 2008b)) and the Curriculum Assessment Policy Statements (CAPS) (DBE, 2011b).

The NCS (National Curriculum Statement)

A new post-apartheid curriculum (Curriculum 2005) for Grades R–9 was introduced in 1998. Driven by a political rather than an educational agenda, it had to clearly reject the apartheid curriculum (Harley and Wedekind, 2004). 'Content' was replaced with 'Outcomes' (skills, knowledge and values) based on constructivist methods (Mattson and Harley, 1999) which rejected memorisation (DBE, 2009). Academic and everyday knowledge were integrated to make the curriculum relevant to learners (Harley and Wedekind, 2004; Le Grange, 2008). It was criticised for being incomprehensible and lacking content and structured progression. This led to the 2000 Curriculum Review process which recommended substantial changes. A revised National Curriculum Statement (RNCS) for GET (Grades R–9) was implemented in 2002. It contained a stronger content focus but the key characteristics of C2005 (outcomes-based, integrated knowledge and learner-centredness)

remained in place. This led to concerns that it was unsuitable for poorly-resourced schools. It's broad vision neglected realities on the ground (Harley and Wedekind, 2004). The RNCS provided the basis of the new FET (Grade 10–12) curriculum, which was introduced incrementally into schools from 2006 to 2008. Agricultural Sciences was now only offered at FET level and no longer provided at primary schools.

In 2008, the first cohort of matriculants completed the NCS (DOE, 2003; 2008a; 2008b) in Agricultural Sciences. Poor results and the lack of agricultural skills development raised concerns (Parliamentary Monitoring Group, 2009; Province of the Eastern Cape Education, 2008). In 2008 all subjects in the NCS (DOE, 2003; 2008a; 2008b) were expanded with two further documents: The Learning Programme Guidelines (DOE, 2008a) and the Subject Assessment Guidelines (DOE, 2008b). Criticisms continued, focusing on poorly specified academic content, concepts and skills and a lengthy, confusing and vague curriculum (Harley and Wedekind, 2004). In 2009 a review of the NCS (DBE, 2009) led to the proposal of a new simplified curriculum.

The National Curriculum and Assessment Policy Statement (CAPS)

The NCS (DOE, 2003; 2008a; 2008b) was revised and renamed the Curriculum and Assessment Policy Statement (CAPS) (DBE, 2011b) and introduced incrementally from 2012 to 2014. The Learning Outcomes and Assessment Standards of the NCS (DOE, 2003; 2008A; 2008B) were discarded. Text books are seen as an essential tool for implementation of the curriculum (DBE, 2009; DBE, 2011b). The CAPS (DBE, 2011b) emphasises detailed foundational knowledge, structured progression and simplified assessment.

In the CAPS (DBE, 2011b) for Agricultural Sciences, the assessment requires a reduction in research projects. A range of assessment approaches are included in addition to tests and examinations. The CAPS has a stated aim to develop research, problem-solving and critical thinking skills (DBE, 2011b; DBE, 2009). The CAPS (DBE, 2011b) still emphasises applied meaningful knowledge in order to enable learners to move from school to the work

environment (DBE, 2011b). This creates expectations of a vocational component in the Agricultural Sciences curriculum.

Conceptual framework

In order to address the three research questions, the NCS (DOE, 2003; 2008a; 2008b) and CAPS (DBE, 2011b) are analysed in terms of the content, knowledge levels and cognitive processes, philosophies of education for sustainable agriculture and the role of assessment and the stated purpose of the curricula.

The content is analysed in terms of whether it supports industrial agriculture (also described as production, chemical and high-input agriculture) or sustainable agriculture. The knowledge dimensions and cognitive processes are analysed using Bloom's Revised Taxonomy (Krathwohl, 2010). The taxonomy is a hierarchy which moves from simple, concrete knowledge to greater levels of abstraction and complexity. Generally curricula tend to rely on the lower end of the taxonomy (facts and memorisation) although higher cognitive processes are important in the learning process. Curricula are analysed in the two dimensional table below.

Table 1: Blooms Revised Taxonomy of Knowledge

	The Cognitive Process Dimension					
The Knowledge Dimension	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create
A. Factual Knowledge						
B. Conceptual Knowledge						
C. Procedural Knowledge						
D. Meta-cognitive Knowledge						
Totals						

In the vertical dimension, factual knowledge includes basic terminology and elements of a discipline. Conceptual knowledge includes relationships between elements, classification, principles, theories and models. Procedural knowledge concerns how to do things. Metacognitive knowledge concerns knowledge of cognition including one's own. The horizontal dimension consists of six cognitive processes:

1. Remember: retrieving relevant knowledge.
2. Understand: determining the meaning of knowledge.
3. Apply: carrying out a procedure.
4. Analyse: breaking knowledge into components and identifying relationships and overall structure.
5. Evaluate: making judgements based on criteria.
6. Create: putting elements together to form something new.

Each statement can have more than one knowledge dimension, but higher levels of the cognitive processes subsume the lower levels.

Education for sustainable agriculture

I contrast the philosophies underlying education for sustainable agriculture with those underlying industrial agriculture education. The description below provides the criteria for content analysis of the curricula.

Education for industrial agriculture fits predominantly within behaviourist and liberal philosophies of education. Behaviourist philosophy aims to transfer a body of knowledge and skills to learners (Francis, 2005; Parr, Trexler, Khanna and Battisti, 2007). Learners are assessed through evidence-based tasks, with examinations providing reward or sanction (Walter, 2009). Liberal agricultural education, focuses on agricultural disciplines such as soil science, agronomy and animal science which contrasts with the more systemic approaches of sustainable agriculture (Bawden, 1995; Francis, 2005, Walter, 2009). The emphasis is on individual learning and the aim is to respond to global economic demands (Clover, Jayme, Hall and Follen, 2013). Behaviourist and liberal education also supports weak sustainable agriculture, which aims to modify industrial agriculture. Based on his work with working-class British learners, Bernstein (in Guthrie, 2013) argues that the traditional forms of education, which are teacher rather than learner-centred are more appropriate for disadvantaged learners. Bernsteinian arguments for "powerful knowledge" (Young in Hoadley, 2011) based on a strongly specified curriculum entered the education debate in South Africa with the NCS (DOE, 2003; 2008a; 2008b) Review Report in 2009 which led to the development of the CAPS (DBE, 2011b).

Education for strong sustainable agriculture engages with progressive forms of education. It advocates humanist and progressive philosophies of education with some streams using radical philosophies. Progressive philosophy integrates the principles and application of science with hands-on agriculture (Bawden, 1995). It includes ecocentric approaches with humans viewed as part of natural systems (Walter, 2009). The educator is a learner-centred facilitator who encourages experiential outdoor learning, experimentation, scientific methods, practical problem-solving, teamwork, internships, democratic thinking and environmental ethics. Assessment takes place

through demonstration of knowledge and not only through tests and exams (Walter, 2009).

Humanist philosophy focuses on personal transformation, self-actualisation and happiness (Walter, 2009) and promotes systems-based curricula integrating natural and social sciences (Parr *et al.*, 2007). It values the connections between humans and nature. It underpins strong sustainable agriculture's focus on the global food system, which requires interdisciplinarity and systemic approaches (Francis, Lieblein, Gliessman, Breland, Creamer, Harwood, Salomonsson, Helenius, Rickert, Salvador, Wiedenhoeft, Simmons, Allen, Altieri, Flora and Poincelot, 2003; Parr *et al.*, 2007).

Some strong forms of ESA are aligned to radical philosophy where there is no externally imposed curriculum and learning occurs through participation, action research, debate, analysis and reflection (Pretty, 1995; Parr *et al*., 2007) in addition to practical knowledge (Perez, Parr and Beckett, 2010). This entails a shift to situated non-formal learning such as farmer groups rather than formal courses (Knight, 2002) such as school Agricultural Sciences. Radical pedagogy, based on Freirean ideas has its origins in adult education. The appropriateness of this pedagogy for school learners is contested (Hugo and Wedekind, 2013).This pedagogy requires specific teaching skills, which are lacking in the South African context, and contributed to the recent demise of the progressive NCS (DOE, 2003; 2008a; 2008b) .

Table 2: A typology of paradigms and philosophies for agricultural education (Adapted from Clover *et al*., 2013; Walter, 2009; Guthrie, 2013)

Philosophy	Purpose	Instructor role	Learning approaches	Assessment
Behaviourist	Knowledge and skills transfer: in order to ensure survival	Teacher as leader Clear boundaries between teacher and learner	Knowledge revealed by teachers Structured external incentives and disincentives (marks, passing/failing)	Measurable outcomes, evidence-based, examinations
Liberal	Intellectual, spiritual, aesthetic, moral development	Teacher has expertise in discipline	Discipline-based scaffolded knowledge; book-centred	Subject matter exams, essays, recitation
Progressive	Development of democracy, social reform and the individual	Teacher as guide and facilitator Boundaries between teacher and learner are weakened	Knowledge discovered by learners Learner-centred, hands-on, outdoor, experiential, problem-based learning. experimentation,intern-ships, scientific method Co-operation, community building and ecocentric approaches	Observation and demonstration
Humanistic	Self-actualisation: social, emotional, spiritual and intellectual development	Teacher as facilitator, promotes personal growth	Holistic, subjective learning; problem-centred; group work, learner takes responsibility, includes social sciences	Self-evaluation, individual learning contracts
Radical	Liberation from social, economic and political oppression; social transformation	Teacher as facilitator, co-investigator, organiser, activist	Conscientisation through dialogue, reflection, action, problem-posing	Increased critical consciousness, political action, visible social change

The role of assessment

Assessment requirements have a powerful influence on how curricula are used, as teachers will teach in order to achieve maximum pass rates. If assessment requirements are predominantly based on memorisation for examinations, progressive teaching which underpins strong ESA is unlikely to gain a foothold. Progressive education uses assessment as a learning tool, rather than just to evaluate final student performance (Chappuis and Stiggins, 2002). Using practical demonstrations, experiments and self-reflection, progressive assessment prepares learners to practice agriculture rather than merely providing generalist grounding in agriculture (Chappuis and Stiggins, 2002;Walter, 2009).

However, although the curriculum may encourage or permit progressive assessment, it is unlikely to be adopted if it is not mandatory. It is more difficult to apply than traditional assessment and thus teachers are likely to avoid engaging with it (Barnes, Clarke and Stevens, 2000; Stevenson, 2007).

Methodology

I analyse the NCS (DOE, 2003; 2008a; 2008b) and CAPS (DBE, 2011b) by focusing on the three research questions.

Coding the documents

I use a qualitative, interpretive methodology to classify sentences or topics in the curricula. I use the sentence as the unit of analysis as well as topics from lists that occur in the curricula. I code each statement (sentences or listed topic) on an Excel spreadsheet. The methodology generates quantitative data, as I count the number of statements in each category and calculate them as a percentage of the total number of statements counted.

I consider all chapters and sections that are specific to the Agricultural Sciences curricula but omit generic sections that apply to all subjects. I exclude tables of contents and glossaries as these are repetitions of information in the curricula. I code repetitions of sections only once, for example the Learning Outcomes in the NCS (DOE, 2003; 2008a; 2008b). I

only code statements that are relevant to the research questions. For question 1, I code statements that refer to or imply a type of agriculture. For question 2, I code statements that refer to knowledge or cognitive processes required in the curricula. For question 3, I code statements about assessment or purpose that refer to sustainable agriculture or ESA.

Question 1: To what extent does the content support sustainable agriculture as opposed to industrial agriculture?

To answer this question I code each statement that makes specific reference to a type of agriculture either as industrial agriculture (IA) or sustainable agriculture (SA). In both curricula, industrial agriculture is the default approach, which is promoted nationally by the Department of Agriculture. I code statements about agriculture which do not indicate the approach, as industrial agriculture. I then code these statements at a second level, indicating whether they provide a broad statement of vision or a detailed statement.

The frequent mention of the word 'sustainable', particularly in the NCS (DOE, 2003; 2008a; 2008b) is not coded as sustainable agriculture unless the context specifically indicates that it refers to environmental sustainability.

The concept is operationalised in Appendix A.

Question 2: To what extent are the knowledge and cognitive processes aligned to philosophies underpinning ESA?

I use Bloom's Revised Taxonomy of Knowledge to code each statement that refers to knowledge or cognitive processes required in the curricula. In the NCS (DOE, 2003; 2008a; 2008b) documents this includes the definitions, learning outcomes, assessment standards, content and context. Statements can have more than one knowledge dimension, but only one cognitive process, as higher levels subsume lower levels.

Where statements provide content with little information on cognitive processes, I code as the lowest level, 'remember', as there is no requirement to go beyond this. The knowledge requirements and cognitive processes are used as a basis for a discussion on the education philosophies underlying the curricula.

The concept is operationalised in Appendix A.

Question 3: To what extent are the stated purposes and assessment aligned to sustainable agriculture and philosophies underpinning ESA?

In addition to coding statements and topics in the curricula, I use the coding process in Question 1 and 2, to code the purpose and assessment requirements of each curriculum.

Findings

Question 1: To what extent does the curriculum promote sustainable agriculture as opposed to industrial agriculture?

Although both curricula are aligned to the default mode of industrial agriculture they also engage with sustainable agriculture. The NCS (DOE, 2003; 2008a; 2008b) provided a vision of sustainable agriculture that was poorly supported with details. The CAPS (DBE, 2011b) provides little vision of sustainable agriculture but provides more depth and detail on ecological systems and sustainable agriculture methods. Opportunities for critical thinking and engagement with socio-economic issues were contained within vision statements of the NCS (DOE, 2003; 2008a; 2008b) but there was a lack of detailed support. The CAPS (DBE, 2011b), with it's focus on traditional agricultural disciplines, has almost no engagement with these aspects.

These findings are elaborated below:

The NCS (DOE, 2003; 2008a; 2008b) provided a strong vision for sustainable agriculture (40% of statements) compared to the CAPS (DBE, 2011b) (6%), but the NCS (DOE, 2003; 2008a; 2008b) has a lower percentage of detailed statements (26%) on sustainable agriculture compared to the CAPS (36%) (DBE, 2011b), suggesting the concept remains an ideal. The CAPS (DBE, 2011b) has a detailed discipline-based focus on sustainable agriculture (soil science, plant science, agro-ecology, animal science) which contribute to ecological literacy, which is foundational for sustainable agriculture. The CAPS (DBE, 2011b) includes sustainable agriculture methods such as free range, organic, biological, integrated, small-scale and backyard agriculture.

The content of the CAPS (DBE, 2011b) provides more support for sustainable agriculture than that of the NCS (DOE, 2003; 2008a; 2008b) .

In both curricula, industrial agriculture is the default approach, promoted nationally by the Department of Agriculture. Many statements containing agricultural content do not indicate the agricultural approach. Unless specified, the dominant mode of industrial agriculture applies. The statement: "*Poultry: Broiler production; and Egg Production: Basic requirements for successful production (housing, management, breeding and nutrition*" (DBE, 2011a:25), refers to the dominant intensive production systems. Sustainable agriculture systems such as free-range or organic would have to be specified.

The detailed support for sustainable agriculture in the NCS (DOE, 2003; 2008a; 2008b) focused on water and soil conservation (7%) which is most commonly aligned to industrial agriculture. There was some detailed support for strong sustainable agriculture such as organic agriculture (7%). The topic 'Organic fertilisers' illustrates an important difference between the NCS (DOE, 2003; 2008a; 2008b) and the CAPS (DBE, 2011b). While the NCS (DOE, 2003; 2008a; 2008b) contained one statement: "*Mineral nutrition: organic and inorganic fertilisers*" (DOE, 2003, p.28), the CAPS (DBE, 2011b) provides four statements detailing different kinds of organic fertilisers such as green manure, farm manure and compost (DBE, 2011a).

Table 3: Percentage of statements coded by type of agriculture

	Vision statements		**Detailed content or strategies**	
	NCS (n=57)	**CAPS (n=89)**	**NCS (n=57)**	**CAPS (n=89)**
Type of agriculture	Percentage of all statements			
Industrial agriculture (IA)	9	1	25	57
Sustainable agriculture (SA)	40	6	26	36

Neither the NCS (DOE, 2003; 2008a; 2008b) nor the CAPS (DBE, 2011b) fundamentally challenge the industrial food system and tend towards weak sustainable agriculture. While the NCS (DOE, 2003; 2008a; 2008b) created

some opportunities for critical thinking, e.g. an exemplar assessment task to compare traditional and industrial agriculture, there are few supporting guidelines. Many of the sustainable agriculture strategies in the NCS (DOE, 2003; 2008a; 2008b) were compatible add-ons to industrial agriculture e.g. organic fertilisers and integrated pest management (IPM). A controversial topic, such as concentrated animal feeding operations (CAFOs) is addressed in the CAPS (DBE, 2011b) with information on animal diseases and management as well as alternative production systems but it does not make use of the opportunity to explicitly critique the industrial food system.

Socio-economic issues are an important part of strong sustainable agriculture. The NCS (DOE, 2003; 2008a; 2008b) contained socio-economic vision statements (14%) such as: "Learners need to be sensitive towards their natural environment and understand the effects of human decisions resulting from socio-economic and political conditions which have an impact on the environment and on sustainable agricultural production" (DOE, 2003, p.13), but these were poorly supported with detailed statements (8%) which include a socioeconomic component within sustainable agriculture. The CAPS (DBE, 2011b) has little focus on socio-economic issues within sustainable agriculture at either the level of vision or in detailed statements.

The lack of critique of industrial agriculture in the CAPS (DBE, 2011b) reflects the tension underlying the shift from NCS (DOE, 2003; 2008a; 2008b) to CAPS (DBE, 2011b), where the transmission of discipline knowledge has replaced an earlier and largely unsuccessful ideal of holistic, critical engagement.

Table 4: Sustainable agriculture statements with a socio-economic focus as a percentage of the total number of statements

Socio-economic vision statements		Socio-economic detailed statements	
NCS n=57	**CAPS n=89**	**NCS n=57**	**CAPS n=89**
14%	2%	8%	2%

Question 2: To what extent are the knowledge and cognitive processes aligned to the philosophies of ESA?

The knowledge requirements in the NCS (DOE, 2003; 2008a; 2008b) were spread over Bloom's Revised Taxonomy with a heavier weighting towards the middle and lower end. In contrast to this, the CAPS (DBE, 2011b) shows a noticeable shift down the hierarchy, with almost double the percentage of knowledge statements at the lowest level cognitive process 'remember' compared to the NCS (DOE, 2003; 2008a; 2008b). In the CAPS (DBE, 2011b) there is substantially less spread into the higher levels of the taxonomy. These findings are elaborated on below.

The spread of knowledge requirements in the NCS (DOE, 2003; 2008a; 2008b) showed heavier weighting towards the middle and lower end of the Taxonomy. The largest proportion of knowledge statements (30%) required no more than remembering factual knowledge. This was followed by understanding conceptual knowledge (23%) and applying procedural knowledge (21%). There were some requirements to work at top three cognitive levels (16%). Metacognitive knowledge (knowledge of one's own learning processes) barely occured in the NCS (DOE, 2003; 2008a; 2008b).

Table 5: Percentage of statements assigned to each category of Bloom's Revised Taxonomy of Knowledge for NCS (DOE, 2003; 2008a; 2008b) for Agricultural Sciences 2003 and 2008 (n = 411 statements)

	The Cognitive Process Dimension					
The Knowledge Dimension	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create
A. Factual Knowledge	30	1	0.2	0.2		
B. Conceptual Knowledge	14	23	1.7	6	6	2
C. Procedural Knowledge	0.2	5	21	1	1	0.2
D. Metacognitive Knowledge		0.2				
Totals	44.2	29.2	22.9	7.2	7	2.2

In contrast, the CAPS (DBE, 2011b) shows a clear shift down the taxonomy, with 87% of knowledge statements in the CAPS (DBE, 2011b) at the lowest level cognitive process 'remember' compared to 44% in the NCS (DOE, 2003; 2008a; 2008b). Fifty-five pecent of statements require no more than remembering factual knowledge. Twenty-four require remembering Conceptual Knowledge and 8% require remembering Procedural Knowledge. The CAPS (DBE, 2011b) substantially decreases the emphasis on the cognitive process of 'understanding' with only 2% of statements falling in this category. The application of Procedural Knowledge declines from 21% in the NCS (DOE, 2003; 2008a; 2008b) to 8% in the CAPS (DBE, 2011b). There is substantially less spread into the three highest cognitive processes (2%). Metacognitive knowledge in the CAPS (DBE, 2011b) is at an even lower level than in the NCS (DOE, 2003; 2008a; 2008b).

Table 6: Percentage of statements assisgned to each category of Bloom's Revised Taxonomy of Knowledge for the CAPS (DBE, 2011B) for Agricultural Sciences (n = 1068 statements)

	The Cognitive Process Dimension					
The Knowledge Dimension	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create
A. Factual Knowledge	55	0.1	0.0	0.0	0	
B. Conceptual Knowledge	24	2	2.8	0.5	0.2	0.1
C. Procedural Knowledge	8	0.1	6	1.1	0.1	0.3
D. Metacognitive Knowledge	0	0.1	0.0	0.0	0.1	
Totals	87	2.3	8.8	1.6	0.4	0.4

The relationship between the knowledge and cognitive processes and philosophies of ESA is explored in 'Discussion and Implications'.

Question 3: To what extent are the stated purposes and assessment aligned to sustainable agriculture and philosophies underpinning ESA?

Neither curriculum provides a clear statement of purpose. Both include a list of complex statements supporting a vision of sustainable agriculture including socio-economic issues. However, the dominant knowledge requirements in these statements align both curricula with traditional formalistic education rather than the progressive philosophies of ESA. The learning outcomes, found in the NCS (DOE, 2003; 2008a; 2008b), (but not included in the CAPS (DBE, 2011b) played a more important role than the stated purpose as they were linked to assessment standards and content. These contained higher knowledge requirements consistent with ESA but remained at the level of vision.

The NCS (DOE, 2003; 2008a; 2008b) provided nine detailed statements of purpose. Four statements addressed sustainable agriculture issues including ethics, environmental care and humane animal treatment; two statements addressed industrial agriculture and seven statements addressed socio-economic issues (DoE, 2003). Knowledge requirements were at a low level with six statements requiring the lower cognitive process of 'understanding' ; two statements requiring agricultural production skills ('application') and one statement focusing on scientific skills (apply, analyse, evaluate). The CAPS (DBE, 2011b) contains five simplified versions of the NCS (DOE, 2003; 2008a; 2008b) statements of purpose with a similar emphasis.

Table 8: Statements of purpose

NCS (DOE, 2003; 2008a; 2008b): Through the study of Agricultural Sciences, learners will:	CAPS (DBE, 2011b): In Agricultural Sciences learners
• develop awareness of national priorities such as food security, sustainable livelihoods and the alleviation of poverty, considering both subsistence and commercial farming practices, as well as cultural, aesthetic and ethical issues within plant and animal production	
• develop an awareness of the management and care of the environment, natural resources and the humane treatment of animals through application of science and related appropriate technology, with responsibility towards the environment and for the health and well-being of all in South Africa;	Develop an awareness of the management and care of the environment, natural resources and the humane treatment of animals through application of science and related technology;
• develop problem-solving mechanisms within the contexts of agricultural production, processing and marketing practices;	Develop problem-solving mechanisms within the contexts of agricultural production, processing & marketing practices;
• be aware of the social and economic development of the society at large through personal development in commercial and subsistence farming enterprises by communicating, by working effectively in groups, and by being creative and innovative;	Be aware of the social and economic development of the society at large through personal development in commercial and subsistence farming enterprises;
• become informed and responsible citizens (knowledge and skills) in the production of agricultural commodities (while managing natural resources), caring for the environment (attitudes and values) and addressing social justice issues;	Become informed and responsible citizens in the production of agricultural commodities, caring for the environment and addressing social justice issues; and
• be aware of agricultural indigenous knowledge and practices through understanding agricultural science in historical and social contexts;	Be aware of agricultural indigenous knowledge and practices through understanding agricultural sciences in historical and social contexts.
• develop an awareness of gender inequity and other imbalances that exist in the agricultural industry, encouraging meaningful participation of female learners and learners with special educational needs;	
• develop social and personal skills through understanding ethical and responsible agricultural practices in the production and processing of food and fibre and caring for crops and animals; and	
• acquire value through having access and the opportunity to succeed in lifelong education and training.	

The NCS (DOE, 2003; 2008a; 2008b) also contained four learning outcomes which were the framework around which the curriculum was structured. Assessment standards and content were based on the learning outcomes which thus carried more weight than the statements of purpose. All four outcomes included a vision of sustainable agriculture and there was some focus on social issues. They had higher knowledge requirements than the statements of purpose, with all four requiring the cognitive process of 'Understanding', three requiring agricultural skills development ('Apply') and three requiring learners to 'Analyse'. However, while the learning outcomes appeared to be more strongly aligned to ESA, they remained at the level of vision, and were not translated into detailed statements.

The stated purpose of assessment in the NCS (DOE, 2003; 2008a; 2008b) focused on whether learners understood "the application of technology" in agricultural production (DOE, 2008b, p.7) and indicated a low cognitive demand not consistent with strong ESA. The CAPS (DBE, 2011b) does not state a purpose for assessment.

The formal assessment requirements ultimately guide the teaching process. The annual assessment requirements are similar in both curricula but are more detailed in the CAPS (DBE, 2011b) (see Table 9). Both curricula derive the year mark from school based assessment (SBA) (25%) and final examinations (75%). Although the CAPS (DBE, 2011b) describes progressive approaches for formal assessment tasks: "science investigative skills. . . hands-on activities or hypothesis testing. . . practical investigations in groups, individually or as a teacher/learner demonstration" (DBE, 2011a, p. 65), it must be noted that only 15% of the SBA in the CAPS (DBE, 2011b) is based on practical tasks, as opposed to tests or examinations. The NCS (DOE, 2003; 2008a; 2008b) did not specify what percentage of the SBA should be practical tasks. The NCS (DOE, 2003; 2008a; 2008b) specified a mandatory 'Performance Assessment Task' focused on the application of agricultural skills and knowledge outside the classroom. SBA tasks are more strongly specified in the CAPS (DBE, 2011b) and include a mandatory practical scientific investigation, but there is no requirement for any agricultural field practicals. All tasks in the CAPS (DBE, 2011b) may take place in the classroom, laboratory or in the community. In the NCS (DOE, 2003; 2008a; 2008b) there was a mandatory requirement for a practical agriculture task as part of the SBA. Developing skills in practical agriculture, plays an important role in ESA, particularly at the strong end of the continuum.

Table 9: Assessment requirements in NCS (DOE, 2003; 2008a; 2008b) and CAPS (DBE, 2011b)

NCS 2003/8 Assessment requirements		**CAPS Assessment requirements**	
Grade 10/11	Grade 12	Grade 10/11	Grade 12
School based Assessment (25%) 2 tests 1 examination 3 tasks (projects, practical investigations, simulations or research projects)	**School based Assessment** (25%) 2 tests 2 examinations 3 tasks (assignment, project, research task) Tasks include a practical agriculture Performance Assessment Task	**School based Assessment** (25%) 2 tests 1 examination (10%) 3 tasks: practical, assignment and research project (15%) Tasks include a compulsory practical scientific investigation	**School based Assessment** (25%) 3 tasks: 2 practicals and 1 assignment (15%) 2 Tests (2.5%) 2 exams (7.5%) Tasks include a compulsory practical scientific investigation
Final Assessment (75%): End of year examination	External examination (75%)	**Final Assessment** (75%) End of year examination	External examination (75%)

Suggestions for practical assessment tasks in the NCS (DOE, 2003; 2008a; 2008b) included a survey of eating habits, a debate on land distribution and creating a food garden to research abiotic factors. There were tasks to explore sustainable agriculture issues e.g. comparing traditional and industrial agriculture. The CAPS (DBE, 2011b) task suggestions include exploring climate change and agriculture. Both curricula suggest outdoor agricultural activities such as food gardens and farm visits in the NCS (DOE, 2003; 2008a; 2008b). The CAPS (DBE, 2011b) suggests a grass collection, making compost and identifying soil horizons. Both curricula include scientific practicals such as microscope work in the NCS (DOE, 2003; 2008a; 2008b) and animal dissection and soil sample analysis in the CAPS (DBE, 2011b). Daily assessment in the NCS (DOE, 2003; 2008a; 2008b) showed commitment to scientific skills development, requiring learners to "master their scientific inquiry, problem-solving, critical thinking and application of knowledge competencies" and to conduct practical scientific experiments (DOE, 2008b, p.7). Daily assessment in the CAPS (DBE, 2011b) includes "observations, discussions, practical demonstrations, learner-teacher

conferences, informal classroom interactions" (DBE, 2011a, p.64). However, these are suggestions not requirements as the daily assessment is informal and does not count towards the final mark in either curriculum.

Discussion and implications of the findings

The lack of consensus around the purpose of Agricultural Sciences in South African schools is reflected in the NCS (DOE, 2003; 2008a; 2008b) and the CAPS (DBE, 2011b). Different perspectives from the Departments of Agriculture and Education include preparation for tertiary education, agricultural careers, self-employment on one side and a generalist education on the other. The lack of clear purpose leads to tension within both curricula. Both curricula show a mismatch between statements of purpose strongly supporting sustainable agriculture, in its broader socio-economic context and the lack of critique of industrial agriculture as well as few requirements for hands-on learning.

In 2001, 91% of schools offering Agricultural Sciences were previously black secondary schools, mostly in the rural former homelands (Paterson, 2004). These schools do not have an agricultural focus, agricultural resources and have few teachers with agricultural skills. Specialised agricultural schools are available for very few learners. For some students, Agricultural Sciences provides a generalist education as preparation for tertiary education. However, a large proportion of matriculants are unlikely to find full employment or a place in further education. The challenge for the curriculum is, how, in the face of the constraints described above, to awaken in learners an interest in and love of agriculture, leading to the development of useful skills in small-scale agriculture, in order to supplement their livelihoods.

Although the CAPS (DBE, 2011b) does not insist on the inclusion of practical agriculture, the assessment component suggests, supports and provides space for practical hands-on learning using higher cognitive processes aligned to ESA. However, it is possible for the CAPS (DBE, 2011b) Agricultural Sciences to be taught entirely within the classroom with no hands-on engagement with agriculture, if the teacher is so inclined. The concern here is that unless teachers are either highly motivated or compelled to do practical agriculture, they are likely to favour easier forms of teaching towards the type of assessment required in the final examinations.

Neither curriculum explicitly supports industrial agriculture, but this is the default approach underlying both curricula. The NCS (DOE, 2003; 2008a; 2008b) vision of sustainable agriculture was poorly supported with detailed content or strategies. The strength of the CAPS (DBE, 2011b) is that while it has little vision of sustainable agriculture it provides more depth and detail on foundational ecological knowledge and sustainable agriculture methods than the NCS (DOE, 2003; 2008a; 2008b). This supports critiques of the NCS (DOE, 2003; 2008a; 2008b) that it was visionary but not located in reality. The CAPS (DBE, 2011b) makes fewer unrealistic claims and has a more detailed, structured approach to factual knowledge, indicating a shift from the political and rhetorical nature of the NCS (DOE, 2003; 2008a; 2008b).

Text books and teaching based on the CAPS (DBE, 2011b) are likely to focus strongly on traditional agriculture disciplines including some sustainable agriculture strategies, but are not likely to provide a holistic critique of the industrial agriculture system including socio-economic aspects. Aspects of this critique were included in the NCS (DOE, 2003; 2008a; 2008b) but were weakly supported with detailed content.

The educational philosophies (progressive and humanist, radical) underlying strong ESA require higher levels of knowledge and cognitive processes in order to generate both the practice and development of sustainable agriculture. The shift down the hierarchy of knowledge and cognitive processes in the CAPS (DBE, 2011b) compared to the NCS (DOE, 2003; 2008a; 2008b) indicates a shift away from the education philosophies underlying strong ESA. Conceptual knowledge is required to engage with systems thinking and critique e.g. *understanding human actions within natural ecosystems; understanding the global food system.* Procedural knowledge is required for practical agriculture and scientific experimentation and metacognitive knowledge to engage meaningfully with environmental ethics and for personal growth and positioning. Higher order cognitive processes such as apply, analyse and evaluate are required for scientific and experimentation skills, while problem-solving can require the highest cognitive process of creating new knowledge. Radical philosophy shifts away from an established curriculum and knowledge transfer and engages with multiple perspectives, critical reflection and the need for new, personalised knowledge. It draws on the highest knowledge levels: metacognition and analyse, evaluate and create.

The CAPS (DBE, 2011b) does not *require* teachers to move beyond formalist transmission teaching. While the use of higher order cognitive processes is desirable in school education (Krathwohl, 2010) there are arguments, that formalist pedagogy based on discipline knowledge, is more effective for disadvantaged learners than progressive pedagogy in the hands of unskilled teachers (Guthrie, 2013). The CAPS (DBE, 2011b) presents a shift away from the progressivism of the NCS (DOE, 2003; 2008a; 2008b) which proved difficult to implement with many teachers left floundering. Given the shortage of skilled Agricultural Science teachers, the CAPS (DBE, 2011b) offers more detailed support than the NCS (DOE, 2003; 2008a; 2008b) by providing fundamental knowledge required for sustainable agriculture.

Conclusion and recommendations

In many ways the CAPS (DBE, 2011b) provides a stronger foundation for sustainable agriculture, than the more visionary NCS (DOE, 2003; 2008a; 2008b). The focus on traditional agricultural disciplines in the CAPS (DBE, 2011b) provides basic ecological knowledge as well as some sustainable agriculture strategies. It is more strongly grounded in details than the NCS (DOE, 2003; 2008a; 2008b) which struggled to put the vision of education for sustainable agriculture into practice. The assessment in the CAPS (DBE, 2011B) B provides and describes opportunities for higher order cognitive processes found in practical work, experimentation and discussions.

Without further curriculum change, in-service and pre-service teacher education would be the best point of leverage, for supporting sustainable agriculture in the CAPS (DBE, 2011b). The goal should be to develop the discipline knowledge, and pedagogic and agricultural skills of Agriculture Sciences teachers.

The Agricultural Sciences CAPS (DBE, 2011b) could help improve the livelihoods of the many learners who will not study further or find full time employment by including practical agriculture. Low cost, sustainable agricultural skills can be taught to both pre-service and in-service teachers, by tapping into the expertise found in numerous NGOs and NPOs, who have been practicing these approaches for decades, rather than government agricultural departments. It would require agricultural training and demonstration centres where such agriculture can be practised and taught.

This learning could be combined with a holistic focus which engages broadly with the socio-economic aspects of industrial and sustainable agriculture in order to empower teachers to engage critically with global food systems.

Ideally teachers need to promote higher order learning amongst learners. Teachers need to personally experience such progressive pedagogies where they themselves are required to question, reflect, problem-solve and learn independently. Teacher education needs to practice and teach such approaches. Such learning has greater potential to generate the emotional engagement and critical thinking that would enable teachers to teach the CAPS (DBE, 2011b) curriculum in a more meaningful way. This would require no deviation from the content, but would elevate the cognitive processes beyond the lowest level of 'remember.'

If curriculum changes are a possibility, a single mandatory practical agricultural task should be included alongside the mandatory science task. This adjustment should go hand in hand with teacher development in small-scale agriculture. Mandatory assessment requirements for practical agriculture will work backwards to ensure that practical agriculture is included in teaching.

The CAPS (DBE, 2011b) for Agricultural Sciences has the potential to support education for sustainable agriculture and make a meaningful contribution to rural livelihoods and food security. The future lies in building up the teachers, not in changes to the curriculum.

References

Aliber, M. and Hart, T. 2009. Should subsistence agriculture be supported as a strategy to address rural food insecurity? *Agrekon,* 8(4): pp.434–458.

Baiphethi, M. and Jacobs, P. 2009. *The contribution of subsistence farming to food security in South Africa*. Pretoria: Centre for Poverty, Employment and Growth, HSRC.

Barnes, M., Clarke, D. and Stephens, M. 2000. Assessment: the engine of systemic curricular reform? *Journal of Curriculum Studies*, 32(5): pp:623–650.

Barrow, S. 2006. *South African organic market study.* Bennekom, Netherlands: EPOPA (Export Promotion of Organic Products from Africa).

Bawden, R. 1995. On the systems dimension in FSR. *Journal for Farming Systems Research-Extension*, 5(2): pp.1–18.

Daily Dispatch. 2008. Eastern Cape MEC's speech. 30 December 2008.

Chappuis, S. and Stiggins, R.J. 2002. Classroom assessment for learning. *Educational Leadership,* 60(1): pp.40–43.

Clover, D.E., Jayme, B. de O., Hall, B.L. and Follen, S. 2013. *The nature of transformation: environmental adult education*. Rotterdam: Sense Publishers.

Department of Agriculture, Forestry and Fisheries (DAFF). 2011. *Welcome to the Department of Agriculture, Forestry and Fisheries*. Accessed 3 March 2011 from http://www.nda.agric.za/

Department of Basic Education (DBE). 2009. *Report of the task team for the review of the implementation of the National Curriculum Statement.* Pretoria: Department of Basic Education.

Department of Basic Education. 2011a. *Report on the National Senior Certificate examination results.* Pretoria: Department of Basic Education.

Department of Basic Education. 2011b. *Curriculum and Assessment Policy Statement (CAPS): Agricultural Sciences.* Pretoria: Department of Basic Education.

Department of Basic Education. 2015. *Education statistics in South Africa 2013*. Pretoria: Department of Basic Education.

Department of Basic Education. 2013. National Senior Certificate examination 2013: schools subject report. Pretoria: Department of Basic Education.

Department of Environmental Affairs and Tourism (DEAT). 2006. *South Africa environment outlook. A report on the state of the environment.* Pretoria: Department of Environmental Affairs and Tourism.

Department of Agriculture(DOA). 2005. *The National Education and Training Strategy for Agriculture and Rural Development in South Africa (AET Strategy).* Pretoria: Directorate of Education and Training, Department of Agriculture.

Department of Agriculture. 2008a. *Evaluation of agricultural education and training curricula in South Africa.* Pretoria: Directorate of Education and Training.

Department of Agriculture 2008b. *Teaching Agricultural Sciences: teachers and other teaching professionals in FET and HE stitutions.* Pretoria: Department of Agriculture.

Department of Education (DOE). 2003. *National Curriculum Statement Grades 10–12 (General): Agricultural Sciences.* Pretoria: Department of Education.

Department of Education. 2008a. *National Curriculum Statement Grades 10–12 (General) Learning Programme Guidelines Agricultural Sciences*. Pretoria: Department of Education.

Department of Education. 2008b. *National Curriculum Statement Grades 10–12 (General) Subject Assessment Guidelines*. Agricultural Sciences. Pretoria: Department of Education.

Dugmore, H. 2009. Starve the beloved country. *The Sunday Independent* , 28 September 2008.

Food and Agriculture Organisation of the United Nations (FAO). 2012. *What is conservation agriculture?* Accessed 29 August, 2013 from http://wwww.fao.org/ag/ca/1a.html

Francis, C., Lieblein, G., Gliessman, S., Breland, T., Creamer, N., Harwood, R., Salomonsson, L., Helenius, J., Rickert, D., Salvador, R., Wiedenhoeft, M., Simmons, S., Allen, P., Altieri, M., Flora, C. and Poincelot, R. 2003. Agroecology: the ecology of food systems. *Journal of Sustainable Agriculture,* 22(3): pp.99–118.

Francis, C.A. 2005. Education in agroecology and integrated systems. *Journal of Crop Improvement*, 11(1–2): pp.21–43.

Guthrie, G. 2013. Prevalence of the formalistic paradigm in African schools. *Southern African Review of Education*, 19(1): pp.121–138.

Halweil, B. (2002) Farming in the Public Interest. In World Watch, *State of the World* New York: Norton and Co., 51-74.

Halweil, B. 2002. Farming in the public interest. In World Watch, *State of the World* . New York: Norton and Co., pp.51–74.

Harley, K. and Wedekind, V. 2004. Political change, curriculum change and social formation, 1990 to 2002. In Chisholm, L. (Ed.). *Changing class: education and social change in post-apartheid South Africa*. London: Zed Books, pp.95–220.

Hoadley, U. 2011. Knowledge, knowers and knowing. Curriculum reform in South Africa. In Yates, L. and Grumet, M. (Eds). *Curriculum in today's world: configuring knowledge, identities, work and politics*. New York: Routledge.

Hugo, W. and Wedekind, V. 2013. Six failures of the pedagogic imagination: Bernstein, Beeby and the search for an optimal pedagogy for the poor. *Southern African Review of Education*, 19(1) pp.122–157.

International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD). 2009. *Agriculture at a crossroads: synthesis port.*Washington D.C.: Island Press.

Index Mundi. Undated. *South Africa-agricultural land*. Accessed 6 August 2012 from http://www.indexmundi.com/facts/south-africa/agricultural-land .
Knight, P. 2002. A systemic approach to professional development: learning as practice. *Teaching and Teacher Education*, 18: pp. 229–241.

Krathwohl, D. 2010. A revision of Bloom's Taxonomy: an overview. T*heory into Practice,* 41(4): pp.212–218.

KZN Wildlife. n.d. *Biodiversity stewardship South Africa.* Accessed 26 November 2012 from http://www.kznwildlife.com/conservation/stewardship/biodiversity-stewardship-sa.html

Le Grange, L. 2008. The history of biology as a school subject and developments in the subject in contemporary South Africa. *Southern African Review of Education,* 14(3): pp.89–105.

Mattson, E. and Harley, K. 1999. That's how we teach them: teacher roles and competences in a globalising South Africa. Paper presented at the Kenton Conference at Salt Rock, Durban, 31 October.

Miller, G.T. 2000. *Living in the environment. Principles, connections and solutions*. Pacific Grove: Brooks/Cole Publishing Company.

Neely, J. and Scherr, S. 2003. *Ecoagriculture: strategies to feed the world and save wild biodiversity* . Washington, D.C.: Island Press.

Mangosuthu University of Technology (undated). National Diploma – Agriculture. Accessed 12 March 2014 from http://www.mut.ac.za/agriculture

New Agriculturist. 2008. *Focus on a green revolution for Africa. A*ccessed 28 July 2009 from www.new-ag.info

National Planning Commission (NPC). 2011. *National Development Plan 2030: Our future – make it work.* Pretoria: The Presidency, Republic of South Africa.

Parr, D., Trexler, C., Khanna, N. and Battisti, B. 2007. Designing sustainable agriculture education: academics suggestions for undergraduate curriculum at a land grant university. *Agriculture and Human Values,* 24: pp.523–533.

Parliamentary Monitoring Group. 2009. *National Senior Certificate 2008 results: Department of Education briefing.* Accessed 22 June 2015 from https://pmg.org.za/committee-meeting/9809/

Paterson, A. 2004. Agricultural and industrial curricula for South African rural schools: colonial origins and contemporary continuities. In McGrath, S., Badroodien, A., Kraak, A. and Unwin, L. (Eds), *Shifting understanding of skills in South Africa*. Pretoria: HSRC Press, pp.71–97.

Perez, J., Parr, D. and Beckett, L. 2010. Achieving program goals? An evaluation of two decades of the Apprenticeship in Ecological Horticulture at the University of California, Santa Cruz. *Journal of Agriculture, Food Systems, and Community Development*, 1(1): pp.107–123.

Pretty, J.N. 1995. Participatory learning for sustainable agriculture. World Development, 23(8): pp.1247–1263.

Reganold, J.P., Papendick, R.I. and Parr, J.F. 1990. Sustainable agriculture. *Scientific American*, June 1990: pp.112–120.

Scherr, S. and McNeely, J. 2008. Biodiversity conservation and agricultural sustainability: towards a new paradigm of 'ecoagriculture' landscapes. *Philosophical Transactions of the Royal Society,* 363: pp.477–494.

SANBI (South African National Biodiversity Institute) 2013. *Life: the state of South Africa's biodiversity 2012.* Pretoria: National Biodiversity Institute.

South African Agricultural Teaching Association. 2007. South African agricultural high schools. Position paper of the South African Agricultural Teaching Association.

South African Organic Sector Organization (SAOSO). 2014. Organic standards. Accessed 22 June, 2015, from http://www.saoso.org/Organic-Standards.php

Stevenson, R.B. 2007. Schooling and environmental education: contradictions in purpose and practice. *Environmental Education Research*, 13(2): pp.139–153.

Tirado, R. 2009. *Defining ecological farming*. Greenpeace Research Laboratories Technical Note 04/2009.

Trading Economics. (Undated). South Africa unemployment rate. Accessed 12 March 2014 from http://www.tradingeconomics.com/south-africa/unemployment-rate

The World Bank. 2008. World development report 2008: agriculture for development. Accessed 31 July 2009 from www.worldbank.org/wdr2008

University of KwaZulu-Natal (undated). Information for high school learners. Accessed 12 March 2014 from http://saees.ukzn.ac.za/Information-For-High-School-Learners.aspx

Van Rooyen, J, Barnard, R. and Van Zyl, J. 1996. Agricultural education and training in South Africa: an overview. *Development Southern Africa,* 13(5): pp.713–729.

Walter, P. 2009. Philosophies of adult environmental education. *Adult Education Quarterly*, 60(3): pp.3–25.

Western Cape Government. 2014. Elsenburg Agricultural Training Institute. Accessed 22 June 2015, from http://www.elsenburg.com/services-and-programmes/elsenburg-agricultural-training-institute#s=Higher-Certificate-in-Agriculture

Wezel, A., Bellon, S., Dore,T., Francis, C., Vallod, D. and David, C. 2009. Agroecology as a science, a movement and a practice. A review. *Agronomy for Sustainable Development*. www.agronomy-journal.org Accessed 24 September 2013.

Appendix A

Operationalising coding for Question 1: sustainable or industrial agriculture?

Level 1: A statement provides a broad vision of industrial or sustainable agriculture.

Level 2: A statement provides a specific strategy or detailed content for industrial or sustainable agriculture.

Table 10: Levels of coding for type of agriculture

Level 1	Industrial Agriculture		Sustainable agriculture	
Level 2	Vision statement	Detailed statement	Vision statement	Detailed statement

Criteria for industrial agriculture

Industrial agriculture is driven by profit and high yields through efficiency, the simplification of ecological systems, mechanisation and synthetic inputs. Environmental and social impacts are viewed as externalities, outside the responsibility of the farmer.

For example:

Industrial Agriculture (vision statement)

"Agricultural Sciences aims to expose learners to the various principles in the production of food whether for subsistence or profit" (DOE 2008a, p.8)

Level 1: The word 'profit' indicates that the statement refers to industrial agriculture.

Note: subsistence agriculture should not be equated with sustainable agriculture.

Level 2: The statement provides specific detail or strategies rather than. A broad vision

Industrial Agriculture (detailed statement)

"Factors to increase animal production under intensive farming (broiler production): Nutrition/feeding; (DBE, 2011a: 49).

This statement refers to intensive animal production, a strategy of industrial agriculture and provides detailed content.

Criteria for sustainable agriculture

Sustainable agriulture refers to alternatives to industrial agriculture. It includes the incorporation of conservation strategies into industrial agriculture and attempts to transform the global food system using alternative methods of agriculture, processing and marketing.

Sustainable agriculture (vision statement)

"Understand and analyse the relationship between human rights, inclusivity, a healthy environment and social justice in sustainable agricultural production" (DOE, 2003, p.25).

Level 1: This statement refers to the concept of sustainable agriculture.

Level 2: The statement provides a broad vision rather than specific detail.

Sustainable agriculture (detailed statement)

"conservation of agricultural resources (soil, water and natural vegetation) and management of the environment" (DOE, 2003, p. 10).

Level 1: This is coded as 'sustainable agriculture'

Level 2: This statement is coded as a detailed statement.

Operationalising coding for Question 2: knowledge dimensions and cognitive processes

The knowledge dimension is identified from the noun or noun phrase. The cognitive process is identified from the verbs that qualify the knowledge dimension (Krathwohl, 2010).

For example:

"The subject Agricultural Sciences should equip individuals with the knowledge and necessary skills to enable them to make sound decisions based on the principles of sustainable agriculture and living". (DOE, 2008a, p.8)

I consider the noun phrase 'knowledge and necessary skills' in order to determine the knowledge dimension. I classify these as factual knowledge (knowledge) and procedural knowledge (skills).

I consider the verbs used in relation to the knowledge dimension: "equip individuals to enable them to make sound decisions". I classify these verb phrases as 'Understanding' (determining the meaning of communication) and 'Applying' (carrying out a procedure). The higher cognitive process of 'apply' subsumes the lower process of 'understanding'.

These are coded in the table below:

Table 11: Blooms Revised Taxonomy of Knowledge

	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create
The Knowledge Dimension						
A. Factual Knowledge			x			
B. Conceptual Knowledge						
C. Procedural Knowledge			x			
D. Metacognitive Knowledge						

When statements contain procedural knowledge without indicating whether learners should perform the process or simply memorise it, I code it as 'Remember' rather than 'Apply'. For example:

"Ways to determine, calculate and interpret the bulk density of a soil" (DBE, 2011a, p.34) is classified as 'Remember" because there is no requirement for learners to apply the process. However: "A practical identification of topsoil and subsoil horizons" (DBE, 2011a, p. 35) indicates that the learners are required to apply a procedure and I code this as 'Apply'.

Moraig Peden
University of KwaZulu-Natal

pedenm@ukzn.ac.za