Teaching and Learning of 'Water for Agriculture' in Primary Schools in Lesotho, South Africa and Zimbabwe

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Abstract

Teaching youths about the subject of water for agriculture is vital in southern Africa where climate adaptation is imperative. Fresh water is a critical natural resource experiencing dangerous scarcity globally, with climate change and variability being key drivers. Agriculture consumes most of the allocated water in most of the southern African countries, so this sector needs particular water harvesting and conservation education. The Food and Agriculture Organisation (FAO) reported that 93% of cultivated land in southern Africa was rain-fed at the beginning of the 21st century. Drought hinders effective agricultural practices in poor-rainfall areas and is a common feature in most southern African countries. Increasingly frequent drought events affect Lesotho, South Africa and Zimbabwe chronically due to climate variability and change. These three countries have school curricula that carry agricultural and sustainability learning to varying extents. Agriculture is taught as a science subject, and tends to be inclined towards normative technicist approaches at the expense of traditional and innovative sustainability practices. This omission in curriculum development and teaching may miss the opportunity to learn from lessons offered by these traditional and innovative systems that have demonstrated resilience to climate variability and change. This paper explores the opportunities and enablers of sustainability learning and relevance in the primary school agriculture curricula of these three countries. The paper argues for inclusion of sustainable agricultural water learning as an act of educational quality and relevance that reflects 21st century socio-ecological, agro-climate and socio-economic challenges in southern Africa.

Key words: primary school, water for agriculture, rainwater harvesting and conservation, learning.

Introduction

Fresh water is a critical natural resource undergoing dangerous scarcity globally, mainly due to ecosystem degradation, population pressure, pollution, and climate change (FAO, 2011). The need for sustainable water resources is found in agriculture and other sectors that all compete for the resource (FAO, 2011). Sustainable agricultural water security refers to the management of water resources for agriculture, respecting the quality and quantity of the resource, minimising negative social impacts and promoting equity, ensuring access to and affordability by all (FAO, 2011). The new Sustainable Development Goals (SDGs) have a focus on improving water resources through poverty eradication (UNDP, 2014).

According to the Food and Agriculture Organisation (2002), 93% of cultivated land in southern Africa was rain-fed at the beginning of this century, and this may have increased with the depression of economies and climate change impacts (FAO, 2012). Agriculture is the mainstay of the economies of most Southern African Development Community (SADC) member states and the vehicle for food security (SADC, 2004). The important role of education and human capacity development in SADC integration is shown by the member states' commitment 'to eradicate poverty through increased public provision of ... education facilities and services' among others (2004:13).

Lesotho, South Africa and Zimbabwe share challenges that are brought about by climate variability and change, exacerbating poor economies and livelihoods. These challenges are characterised by over-reliance on rain-fed agriculture, compromising smallholder subsistence farming and food security (Thompson, Berrang-Ford & Ford, 2010). Enhanced dryness is a result of the regular El Nino phenomenon (SADC, 2015). These conditions impact heavily on agriculture, a sector that the majority of people engage in as smallholder subsistence or commercial large-scale farmers. The education systems of these countries have agriculture either as an independent subject or can be found integrated into different learning areas/subjects from primary level (except for South Africa) to tertiary education in diverse ways.

Our research interest in this paper was to find out how teaching, learning and texts in the primary schools in the three countries were including or excluding the theme of sustainable water for agriculture; in particular, rainwater harvesting and conservation (RWH&C). Water for agriculture (or agricultural water) refers to water that is committed for use in growing fresh produce and sustaining livestock, for which huge proportions of all the water withdrawn from rivers and dams are already allocated (FAO, 2011).

Methodology

A case study methodology was used in this study, using case studies that were conducted in three southern African countries – Lesotho, South Africa and Zimbabwe – on the teaching and learning of alternative water for agriculture in their primary school education systems. The counsel of multiple techniques use is sought from Yin (2008), who argues that validity is strengthened by the use of multiple instruments. A multi-case design was employed with the sample of primary schools in each country constituting the cases, and the unit of analysis in each case is the teaching and learning of RWH&C.

Study site and sample

The study was conducted in the Maseru district of Lesotho; Grahamstown's main township and its neighbouring rural area in South Africa; and in the Mutare urban and rural district of Zimbabwe. The study employed a small sample (number, n=21) in order to provide a snapshot of the extent to which RWH&C artefacts (objectives, topics, physical structures) for teaching and learning exist at primary schools, and to find out if their usage is supported by the curriculum. This could form a base for further, wider research on RWH&C and alternative water for farming for those who cannot afford or access irrigation. Public schools were purposively

sampled taking into consideration the presence or absence of RWH&C artefacts. Claims will be limited to schools characteristic of this sampling and may not be widely generalised. Qualified teachers with a teaching experience of more than two years, who taught across the different primary school phases, were selected in order to represent the whole primary school curriculum. In Lesotho these were foundation (grades 1 to 3), intermediate (grades 4 to 5), and senior grades (grades 6 to 7). In South Africa the phases covered were foundation (grades R to 3), the intermediate phase (grades 4 to 6), and senior phase of the primary section of the senior phase (grade 7). In Zimbabwe the selection covered teachers for junior primary, namely grades 1 to 3 and grades 4 to 7. In Zimbabwe, agriculture occurs as a subject in grades 5 to 7. The phasing is different in the three countries, but the age ranges and primary grades are comparable.

Data generation method

Questionnaires and interviews were used to generate data. A semi-structured questionnaire was administered to seven sampled teachers in each study site to generate primary data on the extent to which RWH&C is taught to learners, and the data was triangulated with one key informant interview in each site. The questionnaires were typed and contained a brief on the cover page about the purpose of the research and the rights and consent of participants who took part in the research. The questionnaire was organised into themes that covered subjects or learning areas where agriculture was mostly found, any topics that relate to harvesting and conservation of water, any practicals done by pupils, and water supply projects in the school. The questionnaires were administered between January and March 2016.

The questionnaire also covered issues of how teaching water in the school was related to pupils' water learning encounters in their communities. The interview schedule was organised in a similar way, but sought teachers' personal and professional relational experiences and efforts. Secondary data was obtained from the curriculum and syllabus documents as well as the prescribed agriculture textbooks from the three countries to find out how much RWH&C content had been included throughout the primary school years in order to support the primary data.

Data analysis

Data was analysed in three main sets: (i) curriculum documents, (ii) syllabi, and (iii) completed questionnaires and interviews. Questionnaires were manually coded, clustered and described according to emerging themes and ideas. The first level of document analysis was to generate data as described above, and the second level was to make sense of the data with respect to triangulation with interviews and questionnaires. The analysis focussed on any topics addressing water in agriculture with specific interest in RWH&C.

Results

This section shows the results of how teaching and learning of water for agriculture was reflected in the multi-sourced data. Availability and use of RWH&C structures in schools, and how they relate to education in water for food was considered a reflection of relevant artefact-mediated teaching and learning in climate and resource-constrained contexts.

Analysis of the primary school curriculum and prescribed textbooks

In the integrated curriculum for primary schools in Lesotho, RWH&C is implied under the scientific and technological learning area. In grade 1, unit 3, learning outcome 16, there is a concept of water conservation (GoL MoET, 2013a:79); while in grade 4, the concept is featured in unit 3, learning outcome 6, under environmental management (GoL MoET, 2013d:92). In grade 5 the concept 'ways of conserving water sources and their protection' is reflected in learning outcome 25 (GoL MoET, 2014:83).

The South African national CAPS for natural sciences and social sciences refer to agricultural indigenous knowledge (IK) in the senior phase (grade 7). The distinct water topic is 'ways of storing water in dams and water tanks', with no reference to agriculture (RSA DoE, 2010:29).

Agriculture is a stand-alone subject done by all learners in Zimbabwe in grades 4 to 7 and is guided by an agriculture syllabus. Soil and water conservation is a sub-topic under the topic 'water' in grades 4 to 7, while water harvesting is a sub-topic under the same topic in grade 5.

Step in Agriculture Grade 5 Pupil's Book is one of a number of Zimbabwe's prescribed textbooks for primary school agriculture that features water for agriculture (Sithole & Jeketera, 2013). Water for agriculture occurs as a sub-topic called 'water harvesting' under water, giving two examples or methods of water harvesting; namely rooftop to tank, and as diversion of part of a river.

In Lesotho, there are textbooks prescribed for each grade and they are organised according to units or learning areas. The Lesotho grade 1 learners' book describes how to save water under the topic 'I care about the world' (GoL MoET, 2013a:26), while in grade 5 the topic 'ways of conserving water sources' is captured in the scientific and technological learning area learner's book (GoL MoET, 2014:32). There are no prescribed textbooks to support primary school agriculture and water learning in South Africa as they appear neither explicitly as subjects nor as topics in the curriculum. Table 1 summarises the results of an analysis of inclusion of agriculture and water for agriculture in policy and pedagogic materials.

Table 1 provides for each country a summary of how agriculture and water are included or excluded in curriculum policy, syllabi and prescribed textbooks. There is a link between agriculture and water learning content from policy or syllabus to textbooks in Lesotho and Zimbabwe, while for South Africa there is a content gap. Teachers rarely use policy documents in Zimbabwe as they work more with syllabi, compared with Lesotho and South Africa where teachers work with curriculum policy statements regularly. However, the syllabi in Zimbabwe have some policy directions, clear aims and assessment objectives as indicated in Table 1. Lesotho's syllabus content is explicit on agricultural learning, for example, learning about manure and composting in school gardens for 'food production and agriculture' in grade 2 (GoL. MoET, 2013b:79). Zimbabwe has agriculture as a separate subject at primary school, South Africa does not have such a subject at this level, while in Lesotho it is under one of the learning areas. The prescribed textbook presents water for agriculture in various forms; for example, 'water harvesting' appears as a sub-topic of water and includes rainwater harvesting and water conservation. However, RWH&C for agriculture is explicitly included in both Lesotho and Zimbabwe syllabi and textbooks, as shown in Table 1.

Table 1. Summary of an analysis of the primary school curriculum documents in Lesotho, South Africa and Zimbabwe

Country and name of curriculum document	Inclusion of agriculture	Inclusion of water for agriculture
Lesotho		
Curriculum and Assessment Policy: (GoL MoET, 2009)	Agriculture under these learning areas: scientific and technological; creativity and entrepreneurial.	Implied under 'Environmental adaptation and sustainable development' (2009:22).
Syllabus	Gardens at school, home, villages. Learning resource grades 1,2 (GoL MoET, 2013a, b).	Water/moisture conservation, uses, source, are topics in grades 1 to 3 & 5 (GoL MoET, 2013a, b, c, e).
Text book(s): e.g. Learner's book by Letsabo, Lenyatsa (2016)	There are prescribed textbooks for each grade.	Conserving water resources: harvesting, storage in grade 5; mini-project to protect, conserve water sources (2016:33).
South Africa		
Curriculum policy: National CAPS Natural Sciences Senior Phase (Grades 7-9)	Agricultural learning is stated but only begins in the secondary grades. Indigenous knowledge includes agriculture and food production.	Management of soil and water (RSA DoE, 2011:8). Focus is on IK, not agriculture.
National curriculum and policy statement (CAPS) for Social Sciences	Agriculture referred to under intermediate phase History and in Geography, under settlement.	Ways of storing water; such as in dams and water tanks (RSA DoE, 2010:29).
Syllabus	The syllabus is incorporated into the CAPS.	The syllabus is incorporated in the CAPS.
Text book(s): none	No prescribed textbooks.	No prescribed textbooks.
Zimbabwe		
Curriculum policy: Agriculture recommended (Nziramasanga, 1999).	Syllabus objectives 2.6 'identify and solve agricultural problems' (GoZ MoEASC, 2012:2),	'Conserve natural resources… within their communities' (GoZ MoEASC, 2012:2).
Syllabus: Zimbabwe Grades 4-7 Agriculture (GoZ MoEASC, 2012)	Agriculture is a standalone subject.	Soil and water conservation a sub- topic in grades 4-7. Water harvesting is a sub-topic under 'water' in grade 5.
Text book(s): Grade 5 (Sithole & Jeketera, 2013)	Example of prescribed agriculture textbook for a grade.	'Water harvesting' for agriculture is a sub-topic (2013).

*Zimbabwe does not have curriculum and assessment policy statements that interface with teachers at the same level as in Lesotho and South Africa.

How primary school teachers perceive agriculture and RWH&C in the curriculum

Teachers in Lesotho indicated that agriculture was taught under the scientific and technological learning areas. They listed various topics related to RWH&C for agriculture including 'water conservation', 'conservation agriculture' and 'proper ways of conserving water sources'. Teachers in South Africa indicated learning areas that had a bearing on agriculture as 'environmental

sciences, social sciences, natural sciences, technology, life skills'. They also indicated that RWH&C was taught with a focus on domestic purposes and not agriculture. Apart from agriculture subject, teachers in Zimbabwe also identified social studies and environmental science as integrating agriculture and water learning. They listed the following topics where RWH&C featured 'water, soil and water conservation, crops, plants and animals'. The following areas were listed by respondents from all countries as spaces for practicals: vegetable production, school greening, soil and water conservation, and animal production.

Responses of teachers on RWH&C structures availability and usage in schools

Respondents from the three countries indicated that RWH&C structures available in the school campuses were boreholes, water tanks, dams, terraces and contours, as shown in Table 2.

Table 2. RWH&C structures availability and usage in schools (no. of respondents n=21)

RWH&C structures in school grounds	Number of occurrences of RWH&C structures in schools			Total no. of responses
	Lesotho	South Africa	Zimbabwe	
Water tanks	3	7	3	13
Boreholes	4	0	2	6
Dams	2	0	2	4
Others (contours, terraces)	1	0	1	2
None	0	0	1	1
Total responses	**10**	**7**	**9**	**26**

*Respondents were given more than one choice of structures to select from and/or add on

Water tanks were the most frequent RWH&C structure, with just under half the respondents in Lesotho and Zimbabwe, and all respondents in South African schools indicating the presence of water tanks in their schools. Boreholes, dams, contours and terraces also featured in Lesotho and Zimbabwean schools, but not South African schools in the sample. Contours and terraces featured the least.

Respondents across the three countries indicated that they also get water from municipal taps to perform agriculture practical lessons but noted cost as a limiting factor. Dominant agriculture projects done by schools in these three countries were vegetable production in school gardens, school greening, soil and water conservation, and animal production. Water tanks in the school campuses were stated to be for domestic use, irrigation of crops and gardens, and for watering livestock (for Lesotho and Zimbabwean schools mostly).

In Table 3 a summary of responses on the importance of RWH&C and the influence of RWH&C structures is presented.

Table 3. Responses of teachers to importance of RWH&C and value of structures

Probing questions	Responses per country	Country
Importance of RWH&C in schools	To teach water conservation, save on water bills, harvest water for school projects, and provide standby water sources during drought periods. For irrigation and domestic purposes (cleaning purposes), as well as for school vegetable and livestock projects.	Lesotho
	To cut walking distance to the water source, have constant water supply, cut on water bills, conserve rain water, and reduce collection of water in holes around school.	Zimbabwe
	To teach water conservation, save on water bills, serve as standby water, provide clean source of water (no chemicals in rain water), solve water shortages/crisis, cut distance walked to the taps.	South Africa
Availability of RWH&C structures and their influence in the teaching of agriculture	It instils a culture of water conservation, helps to store water for agriculture purposes. Enables schools to carry out curriculum based projects, collection and storage of water for later use. Provides materials for water-related practical lessons, as well as water for irrigation and for livestock. And help in the teaching of RWH&C.	Lesotho
	Provides free water to teach agriculture. Irrigation becomes easy. Avails water for promotion of practical lessons.	Zimbabwe
	Promotes water conservation through learning by doing. Provides awareness on saving water and an extra source of water for watering crops. Teaches self-reliance by conserving water. It makes economic and environmental sense.	South Africa

Teachers in the Lesotho sample indicated that RWH&C structures were important for 'irrigation of school vegetable and livestock projects'. Teachers from Zimbabwe indicated that availability of RWH&C structures will have an influence in the teaching of agriculture 'since it will be free water, teachers will be able to teach agriculture without wasting water'. Another Zimbabwean teacher said 'agricultural activities will increase as there will be more water to support these activities' (Teacher 4, 2016). The teacher considered harvested water as a free resource which enhanced agricultural teaching. On the importance of RWH&C, a teacher from Zimbabwe responded by observing that 'pupils understand more when they can actually see what we would be talking about' (Teacher 3, 2016) and another said there will be constant water supply for agricultural water learning.

Teachers in the Lesotho sample said that availability of RWH&C structures

> [instil] a culture of water conservation, [help] to store water for agriculture purposes, to carry out curriculum-based projects, collection and storage of water for later use, avail water for irrigation and for livestock, provide materials for water-related practical lessons, help in the teaching of RWH. (February 2016)

The Lesotho and Zimbabwe primary school teachers demonstrated the relationship between RWH&C and agriculture teaching. The responses from South African teachers again show a link only with domestic use. Table 4 shows teachers' responses to questions on the relationship between schools and the surrounding community regarding RWH&C, with the aim of exploring use of structures for teaching and extension support to schools.

Table 4. Responses of teachers on the relationship between schools and community in relation to RWH&C

Questions	Responses	Country
Community RWH&C structures for teaching purpose	Used for field trips to learn about RWH&C structures and to teach water conservation topics.	Lesotho
	Helps to teach topics on sources of water, crop, plants and animals, as well as soil and water conservation.	Zimbabwe
	They are used to teach topics on climate and vegetation, water conservation, recycling, global warming, sources of water, water cycle, ways of storing water, water as a resource, and management/storage of water.	South Africa
Support from extension service	None/limited.	Lesotho
	They provide help in contour ridging, school greening, permaculture. Some schools did not get support at all.	Zimbabwe
	Provide water tanks, help in gardening, and are involved in eco-schools projects.	South Africa
Assistance required from extension service	Teachers require guidance on how to harvest rainwater, how to acquire RWH&C material, and request donations/ supply of water tanks. Awareness about water harvesting and proper use of water. Construction of safe dams. Guidance on vegetable production. Acquiring affordable means of harvesting water.	Lesotho
	Guidance in how to teach learners about vegetable production, diseases and pests. Provision of more information and knowledge in agriculture about constructing water tanks and protecting of water sources.	Zimbabwe
	Acquiring additional water tanks and replacement of roof gutters. Information on ways of treating tank water, building strong tanks, harvesting strategies and other methods of water conservation.	South Africa

Table 4 shows that RWH&C structures were used for teaching and learning of water sources, soil and water conservation, water storage, and climate. Water for agriculture was looked at differently by the responding teachers in the three countries. Only in Lesotho and Zimbabwe was there a link made between RWH&C structures and agriculture, almost by all respondents.

Six out of seven respondents from the South African case indicated that RWH&C structures were used for domestic purposes, and none linked them to agriculture. A teacher from South Africa described the type of extension the school received as 'there are people from public works who come weekly to our school and help with the garden and cleaning of grounds' (Teacher 1, 2016). This indicates that pupils' involvement in the school garden is minimal or non-existent. There is an indication that school agricultural activity in the South African sample area is linked to the Eco-Schools Programme, which works in only a few schools, under specified guidelines (WESSA, 2013).

The interpretation of the curriculum by teachers presented above is related to the content of the syllabi and learning support materials, as shown in the analysis of the primary school curricula of the three countries.

Discussion of Results

This discussion is based on the results of document analysis and responses from the 21 primary school teachers from Lesotho, Zimbabwe and South Africa involved in this study.

Summary of agricultural water and RWH&C inclusion and exclusion coverage in the primary school curriculum

The integration of rainwater harvesting for agriculture in the Lesotho and Zimbabwe sample teachers' responses is traceable back to the structural influences of policy and syllabi. External intervention by the Eco-Schools Programme in South Africa (done outside the official curriculum process) mediated learning of the subject of agricultural water, where participating schools voluntarily accepted it. This re-contextualisation process shows the power of the politics of knowledge (Rata, 2012), in what counts as knowledge to teach, and the effect of discretionary or official selection on pupils' learning opportunities. At another level, the re-contextualisation process from the syllabus to the textbooks shows the limiting of water harvesting methods to collection in tanks and diversion of parts of rivers (Sithole & Jeketera, 2013:32–33). In-field methods such as small farm dams and deep contours that innovative farmers have used very successfully (Denison & Wotshela, 2009) are not included. This partly explains the re-contextualisation done by the teachers that shows limitations on their knowledge of RWH&C techniques, as reflected in the responses from their interviews above.

Usage of availble RWH&C structures

Respondents in South Africa indicated that roof water harvesting tanks and municipal water were used as a source of water for school agriculture projects; while in Lesotho, boreholes and dams were popular. RWH&C structures that were in the community and available for use by the schools in those communities were water tanks, wells and dams for South Africa, Zimbabwe and Lesotho respectively. Of those structures identified, water tanks and dams were the predominant available RWH&C structures found in the sample schools and the communities in all three countries.

School and community relations

Community plays an important role in having and maintaining RWH&C structures, and availing them to schools for teaching and watering their gardens. In Lesotho, they were used for demonstration when teaching topics of water conservation and different structures used in RWH&C. In the Zimbabwe sample, they were used for topics in soil and water sources and conservation; while in South Africa, such structures were used to teach climate and vegetation, storage of water, and recycling.

Rainwater harvesting and conservation teaching and learning

In the Lesotho, South Africa and Zimbabwe primary schools, all respondents indicated that it is important to teach RWH&C as it helps in the teaching of water conservation, harvesting and storage for school projects. This was supported by the curriculum documents in Lesotho and Zimbabwe that included water and RWH&C learning for food production. The inclusion of RWH&C is relevant to the prevailing climatic, socio-ecological and economic contexts represented by the samples in these countries. Generally, policy and curricula were shown to be enablers of RWH&C teaching and learning in Lesotho and Zimbabwe. Most respondents indicated that RWH&C structures promoted learning, particularly by doing gardening, due to low costs, and they reduced water crises during drought events.

The South African primary school curriculum, however, has little significant agricultural water learning content. Evidence from an interview from an extension NGO indicates that primary school teachers in the sample area were generally reluctant to be involved in agricultural teaching and projects because the subject was not in the syllabus. This reinforces the idea that the South African curriculum policy constrains the teaching of RWH&C in schools for agricultural purposes by excluding it from primary schools.

Conclusion and Recommendations

The inclusion of agriculture and RWH&C in primary school curricula in Lesotho and Zimbabwe enhanced the learning of the subject of sustainable water for agriculture in the sampled schools. From the findings, this was not the case with the South African primary school curriculum and sampled schools. The exclusion of specific agricultural teaching and learning as a subject or topic in the South African primary school curriculum may have implications for pupils' valuing of agriculture and alternative sustainable water for agriculture. Studies on how this exclusion may affect the preparation of the youth for future self-reliance opportunities in agricultural production are recommended. We also recommend that topics of water harvesting and conservation, and food gardens be included in the South African primary school curriculum, as these are heavily promoted by research and national policies. The type of RWH&C promoted in the primary school curricula of all three countries in this study were mainly limited to roof-water. This limits the learning of possible sustainable water for agriculture methods available, such as small farm dams, deep contours, fertility trenches and mulching. The inclusion of sustainable water for agriculture learning, particularly RWH&C, is relevant for adaptation to the socio-ecological and agro-climatic challenges prevailing in southern Africa. Further research

on the learning of alternative sustainable water for agriculture across teacher education, school and community contexts is recommended. Finally it is recommended that curriculum reviews and changes consider integrating or strengthening learning of sustainable alternative water for agriculture and featuring knowledge practices of farmer innovators.

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