Subsistence Farmers' Knowledge in Developing Integrated Critical Pedagogy Education Curricula

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Abstract

Curricular innovation in the 21st century in education requires significant transformation with regards to political, economic, socio-cultural and environmental concerns such as climate change and sustainability, amongst others. A critical pedagogy approach that includes the hegemonic knowledge debates of Western and Indigenous Knowledge Systems is also integral to this transformation. This study explored the diversity of knowledge of subsistence farmers with regard to their community farming practices and how their knowledge, skills and resilience can be harnessed for education. Seven Black South African subsistence farmers near a teaching university were purposively selected for this qualitative multi-case study. Interviews with them were video-recorded and transcribed. Their experiences and perceptions of politics, economics, environmental concerns and innovations on their local farms were documented and are presented as a case-narrative history of the farmers' backgrounds. The findings show that farmers have shown resilience with regard to issues such as water conservation, productive use of labour, pest management, local market supply and demands and indigenous knowledge in terms of ploughing, caring for, harvesting and storage of vegetables. It is recommended that local farmers' knowledge, practices and resilience can be a source of knowledge to be integrated into education curricula. The implication of the research affords insights for opportunities and partnerships with the farming community in developing a critical pedagogy education curriculum that can be of current value in managing climate change and sustainable concerns.

Keywords: Black subsistence farmers; indigenous knowledge; climate change; environmental sustainability; curriculum development; critical pedagogies for education

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Introduction

Curricular innovation in 21st century education requires significant transformation with regard to local and global political, economic, socio-cultural and environmental concerns such as climate change (CC) and environmental sustainability (ES), amongst others. In addition, discourses and debates between Western and Indigenous Knowledge Systems (IKS) from critical pedagogy need to be included. The education problem addressed in this study centres on transforming curricula to develop a deeper awareness and change in practices with regard to the aforementioned concerns (Lozano et al. 2017). This study thus explored the diversity of knowledge of subsistence farmers concerning their community farming practices and how their knowledge, skills and resilience can be transformed into classrooms practices as viewed from a critical pedagogy education perspective.

Currently climate change (CC), environmental sustainability (ES) and Indigenous Knowledge Systems (IKS), from now on abbreviated as CC-ES-IKS, are largely theoretically and discipline-based in research and report papers (IPCC 2014) and barely found as an integrated approach in current textbooks, educational standards and curricula (Meehan, Levy, and Collet–Gildard 2018). In particular, Science, Technology, Engineering, and Maths education (STEM) courses require significant transformation as they are pertinent to concepts of CC-ES-IKS in their disciplines. While CC-ES-IKS are currently significant and crucial areas of research and teaching in university STEM programmes, they are now only slowly emerging in educational curricula and materials (Bybee 2013; Lotz–Sisitka 2011).

STEM is often taught in separate disciplines and while IKS is an expanding area of research, only selected concepts of IKS are being incorporated into school and university education curricula, thus fragmenting an integrated understanding of politics, economics, poverty, unemployment, food and water shortage, climate changes and environmental sustainability, amongst others (Lotz–Sisitka 2011). This paper posits that an interdisciplinary approach to these problems, using appropriate case studies or projects such as a farming community, can address some of the issues of CC-ES-IKS if integrated into curricula. Thus, central to this study is exploring a farming community as a multi-case study and, through critical pedagogy education, reflecting on how their knowledge and skills can be included to transform curricula in education. In this regard, students and educators can co-seek realistic interdisciplinary solutions to the current crises found in their communities such as a lack of fresh water, starvation, environmental damage, amongst others. There is a dire need to equip students with skills through an interdisciplinary and action approach in education, inclusive of community knowledge, via an innovative curriculum for the 21st century. For developing countries, the need is current and urgent as they are faced with multiple societal problems and depend largely on natural resources, thus stressing the environment with large carbon footprints (Scott 2015). Patel and Ulriksen (2018, 1) add that we often neglect the voices of the poor and poverty-stricken in that

> solutions to poverty and social exclusion tend to focus largely on national social and economic policies and the monitoring of national poverty indicators. Often missing from these conversations, but equally important, is the need for a perspective that privileges the knowledge, experience, capacities, aspirations and efforts of citizens and communities to improve their lives. Innovative solutions that connect with people's real-life situations, and that take the voices of the poor into account, are critical in shaping such solutions.

While poor subsistence farmers generally grow crops under difficult climatic conditions as they have the lowest capacity to adapt to climatic changes and will need a diverse range of support and skills such as those held by successful farmers (Nhemachena and Hassan 2007), they are successful and resilient in their practice, overcoming many odds in their daily farming. These farmers engage in small-scale agriculture in the production of crops and livestock on small pieces of land without using advanced and expensive technologies. Their practice is usually characterised by intensive family-supported labour, limited use of chemicals and they supply to the local markets.

Wals and Benavot (2017) note that in critical pedagogy, education and lifelong learning are increasingly used to address the environmental crisis and sustainability where students, in developing skills needed in the 21st century, need to collaborate and work in teams with communities (Scott 2015). Effective ways of learning in Education for Sustainable Development (ESD) require stressing the importance of a "whole institutional" approach to education for sustainability (Lotz–Sisitka 2011). Lotz–Sisitka adds that this approach implies reconsidering and redesigning "schools' operations and environmental management …, pedagogy and learning … and community relationships" (2011, 409–10).

In this regard, the research questions addressed in terms of critical pedagogy education are the following: What science, technology and indigenous knowledge (STIK) are embedded in farming practices of subsistence farmers and how can their knowledge be perceived in terms of critical pedagogy education with regard to curricular innovation?

Literature

Climate change, Sustainable Development Goals (SDGs) and Agriculture

Several reports have noted the link between climate change and poverty in Africa (Signé 2018). The seriousness of the danger of climate change for Africa has been recognised and articulated at the World Summits on Sustainable Development (WSSD). Agenda 2030 is based on the 17 Sustainable Development Goals (SDGs) of which four, namely, SDG 2—higher education, SDG 4—education, SDG 13—climatic change and SDG 16—community, are relevant, responsive and reflect policies on education for sustainable development (ESD) (Wals and Benavot 2017, 4) and impact directly on critical pedagogy education. The Southern African Development Community (SADC) countries, along with other African countries, have recognised and prioritised *agriculture* as key to overall economic growth, poverty reduction, and enhancing food

security and have committed themselves to the shared goals espoused in the Comprehensive African Agriculture Development Programme (CAADP), the SADC Regional Indicative Strategic Development Plan (RISDP) and the Millennium Development Goals (MDGs) (Chilonda and Musaba 2010). CAADP falls under the auspices of the African Union's New Economic Partnership for Africa's Development (AU/NEPAD) whereby NEPAD (Abass 2010) has documented that the severity of the environmental problems in Africa, particularly climate change, is a major contribution to the problem of food security and unemployment and the depressing growth performance in Africa (Signé 2018). While Africa is rich in land and natural environmental resources, with 54 countries of diversified economies, it is experiencing severe droughts, poverty, skills shortages, water shortages, land ownership protests and political upheavals, amongst others. This, together with increasing unemployment and inadequate economic performances, has created major problems in African society (Carbone 2017; Vigil 2017). There is also a growing problem of wide-scale urbanisation as rural communities leave their agricultural lands due to drought, unemployment, etc. (Vigil 2017). In doing so they reduce subsistence farming efforts of growing sustainable crops and thus increase unemployment and poverty levels. Large-scale commercialisation in turn has resulted in poor uptake of farming by poor domestic households and enhanced their dependence on food obtained from the large chain supermarkets, thus reducing some of their meagre income for other essential household uses. There is also evidence that subsistence and home gardens are now minimal whereas previously almost every home or family had a sustainable vegetable garden (Baiphethi and Jacobs 2009). In addition, Baiphethi and Jacobs note that conventional production requires high input costs which most of the poor cannot afford, thus diminishing the prospects of food security for the poorest. Food security in poor communities is also dependent on the ability of countries to collect, preserve and to disseminate knowledge of traditional vegetables and animal husbandry, thus strengthening the case for more collaborative efforts between communities and the sciences, technologies, indigenous research and education.

Subsistence Farmers, Education, Sustainability and the Environment

Black subsistence farmers form a large informal sector of the marginalised local subsistence agricultural sector in Africa and they have a strong, yet untapped, potential to contribute to knowledge and skills relating to CC-ES-IKS for inclusion in education. A participatory approach can help to transform both the local communities' agricultural practices and the formal educational curricula by developing a critical perspective and a systems-based approach to current problems of CC-ES-IKS. Subsistence farmers do have the potential to benefit from scientific practices and technologies and further to contribute their agricultural experiences and indigenous knowledge (IK) to the wider community. Often, they and their IK are neglected, as their products are not commercially viable, and they have little support from the municipality, banks, the state and private cooperatives.

The evidence accumulated by scientists over the years shows that, worldwide, harmful human actions, habits and activities have resulted in an accelerated scale and pace of biodiversity loss, land degradation, ozone depletion and climate change. As the Intergovernmental Panel on Climate Change's (IPCC) Scientific Report and Synthesis Report (SYR) and its implications are not readily translated to educators and students, a transformed education curriculum can help the community and institutions of teaching and learning to understand and respond to global, regional and local environmental issues (IPCC 2014). The SYR highlights that "we have the means to limit climate change and its risks, with many solutions that allow for continued economic and human development" (IPCC 2014, v; WWF 2016).

Internationally, large investments are made in teacher education and in school curricula materials with the aim of supporting STEM growth. However, relatively little evidence is available about learning CC-ES-IKS and the skills needed (Roblin, Schunn, and McKenney 2018) for a critical pedagogy education. Meehan, Levy, and Collet-Gildard (2018) also add that the current curricula offer a narrow view of responding to global climatic change (CC). Educators need to critically examine the materials in terms of the political, economic, and social justice issues portrayed within CC-ES-IKS to effect classroom discourses and action. This study attempts this by reflecting on how subsistence farmers' resilience and experiences of CC-ES-IKS can be integrated in education to effect transformation and innovation to meet challenges of the 21st century.

Conceptual Framework

From the view of critical educational theorists, the enacted curricula in schools and tertiary institutions should be more than programmes and textbooks of information, and should not be viewed merely as preparing students for a dominant or subordinate position in society where dominant forms of knowledge are favoured over others, creating distinct classes of inequality in the process. Gramsci and Freire, in espousing critical education theory, proposed a transformation of society itself to meet the collective needs of individuals while empowering individuals towards critical consciousness of political and cultural change in which relations of power are transformed. This entails a discussion embodying past knowledge as well as new knowledge produced by one's own creative powers as the guiding educational principle for lifelong learning (Aronowitz and Giroux 2003; Knapper and Cropley 2000). In response to advancing this educational principle of critical pedagogies in this study, the adaptability of farmers using past experiential knowledge and skills and their resilience produce new knowledge linked to their historical cultural past, apartheid politics and economic change in which relations of power are transforming at different levels. These levels include the family where the cultural and economic transfer of knowledge and skills occurs, ownership and loss of property due to apartheid policies and the inclusion of workers' rights. These issues impact implicitly and explicitly on students' lives and progress in attending classes.

This current study explored how a community (in this case a group of Black farmers) can contribute to changing their political and economic circumstances and poverty level by adapting their scientific and Indigenous Knowledge Systems (IKS) and skills in farming. Tracking and exploring their experiences can be beneficial in transforming education curricula, especially with current global challenges of CC-ES-IK, and can contribute to broadening mainstream education that is still largely static, bureaucratic and based on traditional discipline content. Critical theorists (Aronowitz and Giroux 2003; Christie 2008) ask how to make schools adequate to a changing economic, political and ideological environment and how the hidden curricula can reveal these inequalities embodied in curriculum policies and classroom practices. According to Dewey's philosophy, farms at schools or farming laboratories or links with local farmers in the community can involve schools as a small society in which communication and cooperation take place, where theory and practice are synchronised, and learning takes place both in schools and within the community's boundaries. Critical theorists such as Gramsci emphasise that offering students a "civil society" of life including the notion of politics and economics should broaden education for lifelong learning and develop them to be independent and responsible. Giroux argues for education in critical citizenship, a democratic practice that will be guided by a morality committed to equality and communal life and taught by teachers who invite students' questions and espouse a sharing of power (Aronowitz and Giroux 2003; Giroux 2011). Integrating farming community knowledge, skills, economics and the politics of farming with students' education can afford a platform for the radical transformation of education goals as proposed by critical theorists and increase momentum towards achieving the UN SDGs from which sociological, economic and political insights can be learnt. Also, the IKS aspects of farming from a critical education theory perspective will afford students the chance to reflect on and evaluate what features reproduce the dominance of Western scientific ways of knowing, why indigenous knowledge was historically subjugated and why there is now a dire need for the transformation of education. The integration of farmers' experiences into the curricula bears prospects, as espoused by critical theorists, to highlight place-based educational issues. This includes reflecting on local and national political and economic realities, historical and present inequalities, scientific and technological research as students engage discursively in the classroom and with their own communities. Place-based education can help increase student engagement and understanding through a multidisciplinary approach as "experiential, and intergenerational learning that is not only relevant but potentially contributes to the well-being of community life" (Gruenewald 2003, 7). For many students who have indigenous roots, exposure to community farms will engage them in retaining and sharing cultural practices. As Cajete (2000, 284) notes, knowledge and science are embedded into the "individual and collective consciousness of our communities." In this regard, the IKS in farming-school community-linked projects can facilitate cultural preservation of ways of knowing and critique the role of science and its reproduction of a single universal way of knowing as dominant in the standard education curriculum (Cole 2007). Such discourses both in the field and in class should lead to transformative action towards achieving sustainable goals in education and in Agenda 2030. Tracking

the UN Sustainable Development Goals (SDGs) (UN 2015), development challenges for humanity including education and economic development, while focusing on climatic change, environmental protection, and indigenous knowledge, can be achieved. For these goals to be attained, the whole community, including farmers, students and researchers in education development, needs to participate and be sustainably connected. For the realisation of these goals, the SDG objectives should be integrated across curricula in education at different levels. While there is a growing trend of studies and attempts to involve communities' knowledge in higher education curricula through service learning, the adoption of their knowledge has hardly been significantly valued and transformed as mainstream and practical knowledge for lifelong learning in a sustainable way (Knapper and Cropley 2000).

Methodology

A multi-case and descriptive qualitative study was carried out in small Black farming communities surrounding a university in South Africa. In multi-case research, the cases need to be similar in some ways; in this study all were subsistence farmers (Stake 2013). The farms were purposefully selected for the study and seven South African farmers (comprising 3 pairs from families and a single farmer) make up the four cases that are reported on in this study. The details of the farmers were obtained through a chairperson of the local community's farmers' cooperative group in the area. It was also convenient, safe and near for the researcher to travel from and to the university during the farm visits. Multiple sources of data were obtained for each case including interviews, field observations and field notes. Yazan (2015) adds that in gathering data from case study research, Yin, Stake and Merriam concur that "it is incumbent upon the case study researchers to draw their data from multiple sources to capture the case under study in its complexity and entirety" (Yazan 2015, 142). Altogether, five male farmers and two female farmers were interviewed voluntarily on their farm fields and in their homes. The interviews were video-recorded and pictures were taken with their permission as well. The interviews were on average 60–90 minutes for each farmer. The interviews covered questions of the farmers' histories and place-based agriculture, politics, economics, current crop practices, and approaches to CC-ES-IKS practices, amongst others. Data was also obtained through farming field observations and field notes. The videos were observed several times and the data were transcribed. The data were analysed for information in terms of 1) their case history narratives and each farmer's views of politics, 2) their farm economics, produce and sales, and 3) how farmers were coping with issues of CC-ES-IKS. In the analysis of the data, the researcher was cognisant that a key feature of case-study research is an acknowledgement that there are "multiple, multivalent realities operating in a situation, and the researcher's view and interpretation is only one of many" (Cohen, Manion, and Morrison 2018, 377). Pseudonyms are used in this research paper.

Data, Data Analysis and Results

The data and data analysis are presented as a case narrative history of each farmer's social, cultural and political background, their knowledge and skills of agriculture, their farm economics, produce and sales and resolution of problems and innovations in farming. All farmers' details are summarised in Table 1. The farmers were assigned pseudonyms. The results of the multi-case study are presented as a discussion analysed through critical pedagogy.

Case 1: Farmer Rita

Historical, Political and Place Background

Rita is a 60-year-old female who has had a long history of farming experience at a small scale and worked with her father from a young age. Her father was a farm manager and leased a farm near the Umlazi river in the early 1940–70s. Her father's farm was forcefully taken away by the Group Areas Act to provide space for a sprawling township and she shifted to a peri-urban residential area in the 1980s. She annexed a piece of vacant municipal land with indigenous and invasive plants next to her home. The land is on a slope, and is prone to erosion after her regular clearing and burning of bushes. She employs one permanent young male worker and two young females as casuals, when ploughing the fields. The male employee is accommodated at her house in an outbuilding. The farm is of a football field size and she extends it when necessary. She has faced numerous problems such as her wealthy neighbours complaining when she cleared the bush, but she argued that if she did not then squatters will come to occupy the land, and so they left her alone. She receives no help from the municipality even though she has approached them for support to adopt the spot. She has used the virgin soil to grow luscious leafy vegetables and added nutrients to replenish the soil by composting with sawdust. Using the dry grass she accumulates, she covers the soil to reduce water loss. She reduces some of the water run-off with the stumps of trees left behind and she is aware of but does not use terrace farming. She employs water-saving and recycling techniques by using several large water storage plastic drums obtained from recycled chemical drums from her husband's factory. She also collects water from the nearby river (500m away by car) and the collected water is carried to the farm in small 20*l* drums and hand-poured on plants. Some farming is also done on her homestead, using vacant plots and a large self-built greenhouse. She uses storage drums and hosepipes from the drums to water the plants. She does regular chemical spraying with chemicals purchased from an agricultural supply store. She uses both commercial fertilisers and her own homemade compost. The farms are weeded daily; the soil is tilled regularly and cared for by regular watering and composting.

Economics, Farm Produce and Sales

Rita grows indigenous herbs (*Amaranthus*), African marigold flowers (*Tagetes erecta*) which she sells for religious functions, bitter gourd (*Momordica charantia*), calabash (*Lagenaria siceraria*), and green chillies (*Capsicum annuum*) etc. She sells her produce

at a large municipal weekend market where she rents a stall and pays a small levy to the municipality. Sometimes she has to hire transport to the market when her husband is unavailable.

Resolution of Problems and Innovations

Owing to the recent invasion of monkeys in the area, her crops were being eaten and damaged by troops of monkeys. She solved the problem by building a greenhouse with the help of her husband, who brought home old piping and nets. She has also purchased dogs to chase off the monkeys. A while back, she added a chicken run with 12–15 chickens. Sometimes she sold chickens at the market. In addition, the eggs were for domestic use. Recently she sold off her chickens as an unknown animal was eating her chickens and she could not resolve this problem, even though she had a sealed wire-net run. She has implemented ingenious water recycling methods such as using her roof to catch water during rains by connecting pipes to huge recycled water storage drums. She also uses her neighbours' excess water from their roofs and water obtained from a nearby river, one kilometre away. She uses both a hose and directly pours water at limited and necessary intervals as required by the plants. She also plants seeds in seasons prior to anticipated rains in spring and summer, using her knowledge of the natural rain seasons. When questioned about her indigenous knowledge of farming, she says she learnt from her father about when (seasons) and how to plant and how to take care of the crops. She said, "My father learnt from his forefathers and they used a variety of seeds and experimented with different crops and over time, they know exactly what to do and when."

She uses limited chemical spraying on crops and knows when, how much and how to use these chemicals. She uses chemicals sparingly due to their high costs. Her knowledge of the long-term dangers of chemicals is limited as spraying masks are not used during her use of the shouldered backpack spraying device, but she does use boots and protective clothing. As her produce of bitter gourd and green chillies cannot all be sold, she has resorted to trial and error in creating pickled products of these vegetables and packaging them in marketable bottles sold at a reasonable profit. She also collects, stores and uses her own seeds, which she refuses to sell or exchange.

Case 2: Farmer Pete

Historical, Political and Place Background

Pete is a young man of 25 years who has taken over his father's farming responsibilities, as his father has become sick with heart ailment. His grandfather purchased the farm in the Cliffdale area, between Durban and Pietermaritzburg in the 1950s. The farms in the area were previously owned by Whites and were sold to Black farmers who came from northern Natal through special permission as the Group Areas Act was enforced. The farm was handed over to Pete's father Perry, who was the eldest son in the 1980s as a traditional transfer of land-ownership practice. There are two full-time male workers on his father's farm. The farm is about the size of three football grounds and has a small

dam built by them. Pete has been working part-time with his father and has developed some skills, but the interview suggested some nervousness in undertaking such a challenging profession as he said that there is a lot of responsibility and uncertainty. He elaborated, "I have to make the farm a success, otherwise my family will be in dire straits financially," and more so he was at pains to narrate that "the family hereditary land will be lost and we will lose our status amongst family members."

Economics, Farm Produce and Sales

Farmer Pete produces traditional vegetables like lettuce, cabbages, and spring onions and he supplies the small shops and the local markets in the area. He explains that the sales are not too high as the local shops want the produce at low cost, forcing him to accept their prices and he is also afraid that the fresh produce will be dehydrated if he runs around searching for individual buyers. He has decided to explore new ways of farming and introduced new crops like tomatoes and peppers that are thriving in a greenhouse he has built himself and with the help of his workers. He has secured second-hand materials and help from a local farmers' cooperative that provides an advisor for hydroponics. He now uses hydroponics and a drip-method in his greenhouse. This innovation is successful as he has produced succulent crops of green and yellow peppers, which he retails at an affordable price to shops.

Resolution of Problems and Innovations

Pete, being young, was willing to explore new crops and ways of growing them on his farm. He has learnt about hydroponics and consulted with cooperatives in the area. To house his hydroponically grown crops, he has built his own large greenhouse with minimal resources. The researcher has sought prices of custom-built greenhouses and found that they are too expensive for struggling small-scale farmers to purchase. Pete has been resourceful and built his greenhouse at less than half of the commercial cost. To develop his knowledge about hydroponics, farming and agricultural products and services, he has used ICT, such as YouTube, a computer, emails, cell phone apps, etc. He does not collect seeds as Rita does, but buys seeds, seedlings, compost, and chemicals from established nurseries and agricultural service companies. He believes that the seeds and seedlings are of good varieties that can grow in the area where frost and occasional hail are experienced. He has no funding from the government or banks and has to rely on his father's meagre farming budget. He has even come to the university to act as a mentor to the students and staff on siting a greenhouse on campus and has suggested where to access support for learning and using hydroponics. When questioned during interviews about "global warming and climatic change," Pete indicated he observes the effects of climatic changes as he has seen the dam on his property starting to dry up and observed the comparatively low rainfalls in the area now compared to the past. Pete says, "I am not sure what to do about it, but I am using drip farming in the greenhouse with hydroponics and we use less water this way and the nutrients are fed directly to the plant roots. It's a way to go."

Case 3: Larry and Ramesh

Larry is a young man who is 28 years old. His well-educated and knowledgeable father Ramesh works alongside him in the Cliffdale farming community. He wants to be a farmer like his father, unlike Pete who has no choice. Larry says, "there are hardly any young farmers nowadays as most youth want to work in corporate and large industries, but I am prepared to work even harder though knowing I might not get a lot of money." They are successful farmers, highly knowledgeable of soils, slope farming, ploughing and they use two tractors. They also let out part of their farm for experimental research in growing a new variety of potatoes, working with the Department of Agriculture (DoA). They employ 10 workers—six females and four males. They grow crops like lettuce, herbs, kale, potatoes, etc. They have a small dam, a pump and sprinklers on their farm. Their farm size is about 10 soccer fields. Interviews with them indicated they grow the "tried and tested" crops and attempt new varieties on a smaller scale. Currently they do not have the skills for hydroponics and will stick to their traditional farming, as it is quite safe and successful. The crops are sold at large commercial stores using their small truck. The DoA has invested in their farm by building a storage warehouse where crops are packed and stored in coolers, seeds are stored in a dry area, and equipment is locked. They have innovated by planting a new crop, kale, as there is a demand by the local Zimbabwean inhabitants who purchase this from the large stores. They have engaged in trialling new varieties of crops and potatoes with the DoA. Larry indicated that he occasionally uses ICT tools when needed like searching the Web for seed prices, etc.

Case 4: Raj and Rani

Raj is 70 years old and slightly ill but still manages the farm. Rani, his 65-year-old wife, helps him with the management of the farm in the Pinetown peri-urban residential area. His two children have left the home as they are educated, earn well and do not want to come back to the farm. He has 13 workers—one male and 12 females. He specialises in herbs like mint and *Amaranthus*, flowers, and garlic. He too supplies the local markets and shops. He has a farm the size of eight soccer fields alongside a fresh-water stream. He drives his own small truck to commercial stores and has built a shed to store produce and tools. Like Rita, he also collects and uses his own seeds and highly values them. He has two pumps, sprinklers for irrigation and connects the pumps daily to the running stream. His wife plants and "owns" her garlic plots and marigold flowers. Raj said that theft of tools and monkey invasions were major and perennial problems. He has thus changed from growing edible stem vegetables like calabash to planting herbs as a result of their invasions. He also keeps dogs to fend off the monkeys. As he has limited manual labour, he has been innovative by purchasing a new motorised plough and he has taught his male worker to use it. Raj said that "this plough has increased my ploughing efficiency and has decreased labour costs and also saves me a lot of time." Raj is resourceful as his farm soil is largely composted with sawdust, freely obtained from nearby furniture shops, and mushroom compost, bought from a nearby factory. They also multi-crop and diversify their crops with a few trees of banana, avocado and

pawpaws. They also have curry leaf trees, lemons and bamboos which are sold to occasional buyers.

Raj is aware that for a good crop of mint herb which is in high demand, the mint must be grown in full sun or light shade and the soil kept consistently moist, hence the use of sawdust. The leaf blight black fungus (*Cephalosporium spp*.) strikes most during damp weather. Much more common than leaf blight is mint rust that weakens the plants and, if left unchecked, can set the stage for leaf blight to take hold and then the leaves are not saleable. While Raj is not aware of the name of the spots that cause fungal spores of the mint rust fungus (*Puccinia menthae*), his experiential learning ensures that he keeps the plants healthy to prevent disease by getting his workers to remove the rust leaves regularly.

Results

Summaries from the above cases of the subsistence farmers' backgrounds and their innovations are presented in Table 1.

Table 1: Small-scale farmers and their innovations and resolutions to problems

Farmer	*Age in years*	*Gender*	*Background*	*Farm produce and sales*	*Resolution of problems and innovations*
Rita	60	Female	Experiential from young age and mentored by father.	Indigenous herbs, vegetables, pickles, chickens, eggs. Sales at municipal market and to neighbours.	Water conservation using recycled tanks. Monkeys' destruction of crops resulted in the use dogs as a deterrent and now the use of greenhouses.
Pete	25	Male	Young and gaining experience from family and through ICT use.	Vegetables, local shops and small community markets.	Hydroponics, greenhouse, ICT tools in farming.
Perry (Pete's father)	58	Male	Experiential and mentored from young age by parents.		

Larry Ramesh (Larry's father)	28 56	Male Male	Gaining experience. Limited use of ICT. Generational experience.	Indigenous herbs, vegetables, and kale.	Experimental farm with DoA. Grows kale for Zimbabwean market.
Raj Rani	70 65	Male Female	Generational experience.	Indigenous herbs, garlic, and flowers.	New motorised plough, sales at commercial shops, new pumps and sprinklers.

Discussion

The literature review reveals the importance of agriculture and its development in terms of local and global economic growth and in alleviating poverty and unemployment. Furthermore, the cited organisations in Africa such as the SADC, and CAADP, amongst others, have focused on agricultural development as their priority. The farmers in this study have intergenerational knowledge of farming practices and skills acquired over many years, passed down from their ancestors. The study reflects that their historical-political, cultural and economic hardships and struggles have over the years not diminished their ambition and persistence in agriculture. In this regard, Shava et al. (2010, 58) also noted "the persistence and potential resilience-building role of traditional forms of knowledge in urban and resettled communities, and that the knowledge holders themselves often express a desire to pass on their knowledge to young people." Apartheid politics in South Africa (SA) via the infamous Group Areas Act have displaced most of the subsistence farmers who have lost contact with their ancestral agricultural lands, but they have recreated new possibilities with smaller farms and sought new activities to improve their economic status. There is very little support from the government or banks given to these subsistence farmers and they are stifled by small pieces of land. Given that in SA, land issues and agriculture are current and heated topics of debate as well as the scenario of poverty, water scarcity and youth unemployment, these farmers and many other subsistence farmers, if given more land, economic and educational support can bolster the levels of development and agriculture in SA. In addition, the subsistence farmers contribute to greening the environment and also network in building the local communities' resources. Krasny and Tidball (2009) acknowledge that landless people who have taken over small vacant dilapidated plots "not only enhance local ecosystems, but also may build social networks and otherwise contribute to community well-being" (2009, 466). Large-scale farming and lands are largely owned by Whites who have historically benefited from apartheid and colonisation and their knowledge, skills and farms are passed down to the next generation, creating a cultural capital for these communities which sows seeds of division and class struggles (Ntsebeza and Hall 2007). While the SA government has released and subsidised a few small farms to Blacks, the lack of support and mentorship

has impeded the sustainability and expansion of most of these farms, creating uncertainty and instability in the land and agricultural sector (Drimie and Pereir 2016).

Data analysis of the two youth farmers in this study indicates they have learnt from their parents but are looking at new possibilities of farming including their traditional way, which is still very successful at producing healthy crops. They are resilient to changing conditions of the environment, have knowledge of a diversity of crops, and have a nuanced understanding of the soil they till and manage with the weather patterns they are exposed to (Lin 2011). They also have unique ways to preserve and collect seed, and grow indigenous herbs and crops against competing alien crops. This is valuable knowledge for us to explore, record and share with the wider community. In addressing agricultural transformation, Oborn et al. (2017) add that women and youth must be involved in integrated systems planning in the agricultural sector as youths have valuable experience with technology that can be tapped into the agricultural sector.

Studies of other indigenous local farmers indicate that they use ash in several ways, however these farmers are not familiar with ash as compost. Like Rita, they do use selected grasses and wood sawdust to make their own organic fertilisers, thus preventing harmful damage caused by industrialised fertilisers and chemical run-off.

All the farmers interviewed practise multi-cropping and rotate their crops regularly. While commercial farmers usually engage in mono-cropping, such as growing mealies, the subsistence farmers in this study do depend on other income sources. It is typical of other farmers (see Table 1) to diversify, for example by using chicken runs, manufacturing pickles, flowers, and growing local indigenous food plants such as yam—"mudumbies," groundnuts, pumpkin, etc.

Regarding problems and solutions and innovative implementations, the farmers have shown resilience with regard to issues such as water usage and costs, worker training, pest destruction, and management of theft. They are also very familiar with the supply and demands of their markets and their community's diet. They thus grow a diversity of vegetables such as indigenous herbs, flowers, kale, etc. They are familiar with the times for ploughing, fruiting, harvesting, storage and market sales. The young farmers Pete and Larry work with cooperatives and agricultural advisors. These farmers have an intricate knowledge of growing indigenous herbs and seeds, pests (intercropping plants with marigold), weather patterns and efficient use of labour. Their main concern is that, while they are able to earn and live a moderate lifestyle, few of the next generation of youths will take to farming though the farmers are willing to share their knowledge, provide internships and use some of their time for mentorship. They complain of very little active and sustainable support from the municipality and government.

Despite the challenges the subsistence farmers experienced, there was also evidence of high levels of resilience. The two women, Rita and Rani, developed communication skills to overcome adversity and tried out different ideas to extend their farming. They

had some financial independence as they obtained their own income from their "own" fields. Their social, family and community support, religious faith and participation in saving in the bank also helped them to remain focused daily on their chores. Researchers in other similar studies have reported that the main adaptation options and coping mechanisms are the following: diversification of crops and animals, expansion of farm size, help from relatives and dependents that live on the farm, supplemental occupations or livelihood diversification and the usage of organic fertilisers (Epule and Bryant 2016; Lin 2011).

In terms of IKS, the farmers have incorporated traditional vegetables used by communities through custom, habit or culture and included a mixture of indigenous and alien species as their crop stocks (Gockowski et al. 2003). In this regard they were engaging in "a dynamic strategy of nutritional resilience" (Muller and Almedom 2008, 599). Gockowski et al. (2003) raised concerns about the rapid urbanisation processes in Africa and alarm over genetic erosion and the loss of these cultural, economic and nutritional resources. While traditional leafy vegetables (TLVs) are still farmed throughout Africa, the farmers in this study also maintain biodiversity of TLVs; for example, they grow yams and bitter gourds as food and medicine for diabetics etc. The young population that consumes fast-foods is not familiar with these foods but by introducing TLVs and restocking supermarkets, interest in purchasing natural nutritional foods is created. Ntuli et al. (2012, 6028) add that IKS and indigenous agroecology are able to incorporate "species onto the 'menu' (to expand the variety of traditional vegetables)" and that a plant's value as a food plant is often "linked to its medicinal value."

Herein lies the educational value of the study as these farmers can contribute toward developing the education curricula. For example, they can help 1) preserve our biodiversity of indigenous plant stocks, 2) retain and add the nutritional value of TLVs to our current use of commercial vegetables, and 3) educate the community about natural foods instead of unhealthy fast-foods. Africa has extreme poverty and, in this regard, TLVs can also be "famine foods" and help to reduce poverty levels as they have a long storage life (Muller and Almedom 2008). TLVs are essential sources of vitamins, minerals, carbohydrates and proteins for poor people (Dovie, Shackleton, and Witkowski 2007; Singh and Garg 2006; Nnamani, Oselebe, and Igboabuchi 2015). There are many arid regions in Africa with extreme temperature ranges. For example, in Kenya, amaranth greens were the only vegetable that survived the drought for one farmer while crops withered in the heat, which encouraged other farmers to consider planting indigenous crops that can be sold easily. Smallholder farmers in Africa are increasingly turning to indigenous crops to diversify their crops. For example, a cousin of the indigenous banana tree called *enset* in Ethiopia is now grown; yams and TLVs are increasingly sold in supermarkets in South Africa, and African indigenous black-eyed beans that are loaded with protein and fibre are also widely used (Ngumbi 2016). Growing indigenous vegetables thus offer Africa's smallholder farmers and local communities part of the solution to the dilemma of malnutrition, adaptation to climate

change and preserving biodiversity. Also, to supplement the food stock, the increasingly known benefits of wild indigenous resources in rural areas and savannahs to feed the poor and deprived households can no longer be neglected in national food databases of countries in Africa (Dovie, Shackleton, and Witkowski 2007; Shackleton and Shackleton 2004).

In a large-scale study Pretty et al. (2006), using sustainable agricultural practices on 12.6 million hectares (roughly 1% of the cultivated area in developing countries) helped to increase the average crop yield by 79%, and it improved water-use efficiency. Also, the use of pesticides declined by 71% while crop yields grew by 42%. The researcher suggests that such successes are best reached when farmers are informed by inter-disciplinary research with strong input from various social sciences (Rechkemmer et al. 2016). The sustainable practices of these farms and farmers in this research are encouraging. If more subsistence farmers practise integrated and diverse farming techniques, using IKS and scientific knowledge responsibly, then it is likely to have significant impact on sustainable agriculture and on development (Darnhofer et al. 2010). In this regard, Pretty, Toulmin, and Williams (2011) add that food outputs as a result of sustainable intensification have been multiplicative whereby yields per hectare have increased by combining the use of new and improved varieties and new agroecological management. This diversification has resulted in the emergence of a range of new crops, livestock or fish that have added to the existing staples or vegetables already being cultivated and the use of small patches of land on raised beds for vegetables. They add that the challenge is now to "spread effective processes and lessons to many more millions of generally small farmers and pastoralists across the whole continent" (2011, 5). For this process to take effect on a large scale, education must be a vital role player, not only in disseminating knowledge of farming practices but also concomitantly developing practical skills in the field.

Implications for Education Curricula Development in Developing Countries

The data in Table 1 and the multiple-case narrative accounts confirm the different ways in which small-scale farmers are engaging in indigenous and inclusive agroecology. The farmers in this research have sought innovative marketing strategies to promote Africa's indigenous green vegetables by supplying local large commercial stores and local markets. However, only certain sectors of the community and elders eat TLVs and more educational campaigns to educate young consumers can be implemented. Such strategies could include repackaging the greens with recipes and preparing sample display sections for tasting. For example, yam is now sold at high-end supermarkets but there is no marketing promotion for this indigenous vegetable in educational institutions. Rita, the female farmer in this study, has created opportunities for entrepreneurship by pickling excess crops (bitter gourd, chillies, and calabash) for storage and preservation, and has promoted nutritious indigenous vegetables to cater for

local tastes. If such practices could be emulated by other farmers, it would create a new line of local industry that can create jobs for the unemployed.

If many more small-scale farmers and home-gardeners are encouraged to grow crops in a sustainable way, then we can reduce the growing and unsustainable practices of mass consumerism. In this regard, Livingston (2018) suggests an ecosocialist approach to production and consumption in achieving an ecological society and addressing mass consumerism, which also impacts on the agriculture sector and sustainable education. He adds that, "this mass production is a fundamental problem that restricts our ability to create an ecological society by being the unshakable cause of most of the environmental problems we face today" (2018, 1).

The farmers are resilient and engage in a sustainable production system. They utilise indigenous crop varieties and seeds, harness agroecological processes such as nutrient cycling, biological nitrogen fixation and minimise the use of technologies or practices that have adverse impacts on the environment and on their workers. They are able to adapt and innovate and resolve common land problems, access clean water and control pests, pathogens and weeds in an ecological way (Lin 2011).

The small-scale farmers can offer much practical and agroecological knowledge and skills to the education community, both for schools and universities, and to the public. It is necessary for the education community to liaise with small-scale farmers in their local areas and form agro-education community networks where their knowledge can be shared, preserved and practised such that the community can begin with their own small gardens and in some cases proceed to sustainable management of larger agroecological farms.

The inclusion of critical pedagogy as a teaching approach will help students to question and challenge colonisation, domination, subjugated knowledge, amongst others, and help them to achieve "critical consciousness" in their lifelong learning. While much of critical pedagogy focuses on culture, language, and domination, a farm-community link to students' curricula that focus on criticising class, capitalism and exploitation as well as seeking action towards achieving SDGs will create agendas of possibilities in their classrooms, making learning relevant, critical and transformative (Darder, Mayo, and Paraskeva 2017).

This study has touched on many topics and concepts that can be covered in a critical pedagogy curriculum and Mkosi (2005) also includes explicit discipline links to indigenous knowledge. These topics include the following:

Agribusiness: Market and sales, business entrepreneurial skills, working with cooperatives and farm advisors, business security, commercial markets, commercial seeds and nurseries, and labourers. *Agricultural/Farm Technology*: Tractor-use technology, new farming machinery, sprinklers. *Farming Systems/Techniques*:

Terracing/slope farming, hydroponics, multi-cropping, natural composting, indigenous crops, drip-farming techniques, seed collection, preservation and storage, new crops and seeds, scientific farming techniques, animal husbandry, infrastructure (storage and transport), bio-security (invasive alien plants).

Climate Change and Agriculture: Climate change observations and effects, natural weather patterns, rainfall patterns, irrigation, animal pests, water hygiene, water retention processes by plants, recycling, chemistry and chemical sprays for food crops, safety of chemicals in their use. *ICT and Agriculture*: ICT, YouTube learning. *History, Politics, Place-based Education:* Ancestral lands, land redistribution and debates, social justice issues, decolonisation.

Conclusion

We have observed that the farmers in the study practise an agroecological approach to farming, which might not be an explicit process for them but that is what they have imbibed in working with the soil and plants. They do have an intuitive sense of climatic change, environment sustainability and indigenous knowledge. They care for the environment, using a minimum of commercial chemicals but still managing to produce crops at reasonable prices sold mostly to the poor. If more poor people are trained as small-scale farmers and allocated land, given that the land issue is still being negotiated in many countries in Africa, the impact on the overall environment will be positive. There will be less unemployment and more ecosocialist approaches to living and stable homes. While commercial farms are needed, their capitalistic monopolisation and monoculture crops have destructive impacts in different ways on the environment. It is up to the poor communities like small-scale farmers in this research who need to network and be supported by academic and socialist movements to promote an ecosocialist, agroecological ideology to stem the tide of rapidly increasing environment degradation, global warming and increased carbon footprints. If the practical, indigenous and theoretical knowledge from the farmers' practices are embedded into the education curricula and integrated together with science and technology then the community and students can work together to mitigate and adapt to climate change.

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