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The potential for inclusive green agricultural transformation: creating sustainable livelihoods through an agroecological approach in Tanzania

Working Paper

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September 2017

CPAN is hosted at the Overseas Development Institute, London

SAT Sustainable Agriculture Tanzania

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Executive Summary

Many argue that the world urgently needs to produce more food for an expanding global population in the face of climate change; and that food security can only be assured through high input and large scale agricultural production. The context for agricultural transformation is changing and a second green revolution must be more inclusive and less environmentally damaging than the first. This paper explores agroecology as an alternative approach to agricultural transformation, offering low-input but knowledge intensive agriculture as a more inclusive and sustainable way forwards.

Food sovereignty approaches already provide a basis for questioning the dominant narrative of increased production. Small-scale agriculture continues to provide a considerable proportion of global food supply. Whilst industrial and 'modernised' food systems cause excess production and waste, as well as depleting and degrading soil and water resources. Inclusive and green food production systems require attention to entitlements to food resources, and access to agricultural resources (e.g. water and land), as well as to the methods of agricultural production.

Agroecology is both a science and a philosophy that approaches agricultural by modelling natural ecological systems. There is increasing evidence that such an approach (alongside other sustainable agriculture approaches) can increase agricultural production for poor and marginal farmers. As a low-input system it has fewer costs, but does require supporting knowledge.

There is a resistance in agricultural policy in Sub-Saharan African agricultural policy to alternative approaches to the dominant narrative of 'modernisation'. The roots of this are very deep and very long. Therefore, our aim in this paper is explore evidence on how agroecology works in a Sub-Saharan African context. Our assertion being that the adoption and promotion of agroecology in agricultural policy could have considerable positive impacts on agricultural transformation for the very poorest, whilst also preventing environmental degradation.

The paper uses a livelihoods framework to conduct a meta-analysis of four empirical studies of the adoption of agroecological practices in the Uluguru Mountains of Tanzania. The data comes from a total of more than 500 small-scale farmers both on the mountains and in the dry lands surrounding the mountains.

We find that:

- Agroecology practices are adopted willingly by farmers, and leads to increased profitability and well-being in their livelihoods.
- That agroecology adoption reduces harmful agricultural practices – such as burning fallow land, and decreases the need for irrigation.
- There is institutional resistance from some government agencies to considering alternatives forms of agriculture

Therefore, we conclude that agroecology has considerable potential to support inclusive and green agricultural transformation in Sub-Saharan Africa, and requires far greater attention from donors and policy-makers

1. Introduction

The Sustainable Development Goals (SDGs) establish targets that will frame future discourse in agricultural transformation. Goal 12 specifically seeks a commitment to decreasing food waste in food production and consumption systems, and more significantly an ambition to 'de-link economic growth from natural resource exploitation' (UN 2016). Set alongside goal 1, which commits to the eradication of absolute poverty, we see a clear imperative for agricultural transformation that is both pro-poor and environmentally beneficial.

The necessity for agricultural transformation is also widely recognised in the debates on structural economic transformation, and as necessary for addressing climate change and facilitating environmental sustainability (Mdee et al 2016). In theory, agricultural transformation increases the productivity of labour, so releasing labour to enable industrialisation to take place. However, there is no fixed route for this process. Current agricultural production practices are a major source of carbon emissions, and the technologies have been developed to minimise the use of labour, to the extent that if they were widely adopted far more labour would be released than could be employed in a modern industrial sector. However, there is evidence that investment and intensification of labour in small-scale farming can be one route to transformation (Mdee et al 2016, Wiggins 2016). Hence, the increased focus on 'climate-smart agriculture' (Campbell et al 2014), and 'sustainable intensification' (Firbank 2012, Pretty et al 2011) within the mainstream literature, for example the World Bank Shock Waves Report (Hallegatte et al 2015).

The narrative is commonly expressed in terms of the Green Revolution, which revolutionised agriculture in many parts of Latin America and Asia in the 1960s. Similar technologies, based on hybrid seeds, chemical fertilizers and insecticides, and where feasible mechanisation, are now being promoted as the solution for Africa, in what is sometimes called a Second Green Revolution. To put this in context it is helpful to follow scholars such as Raj Patel (Patel 2013) who set out to understand the forces that drove the first Green Revolution.

In 1941 the Rockefeller Foundation agreed a programme with the Mexican government to develop high-yielding varieties of food crops, especially wheat which could be grown on large mechanised farms. A few years later, new varieties of maize were created in India, even though it was not an important food crop in that country, and new varieties of rice were developed in the Philippines.

All these depended on chemical fertilizers and insecticides, and were hybrids, which meant that farmers using them have to purchase new seeds each year, making them extremely attractive to companies selling seeds. The Rockefeller (and later also the Ford) Foundations worked closely with international chemical and seed companies, and concentrated their activities where there were large or relatively large mechanised farms. What became known as the Green Revolution was further extended, for countries willing to allow the use of genetically modified seeds, when the Monsanto companies created varieties that would resist its weed killer Roundup, based on the active ingredient glyphosate.

However, by 1970 this first phase of the Green Revolution was winding down. It had led to greatly increased production of cereals, with very large areas planted with identical seeds. But new pests and weeds were appearing, yields were no longer increasing, irrigated land was becoming saline, and the wider consequences were becoming recognised, including the fact that many small farmers had lost their land and were living in poverty. The problems of small and more marginalised farmers were exacerbated by their inability to resource the required inputs of seeds, pesticides and fertilisers (Patel 2013). In addition, the increased use of pesticides, mono-cropping and fertilisers had negative environmental impacts and there were adverse public health consequences from the powerful insecticides and weed killers (Ngowi et al (2016); Westegen & Banik 2016). Governments were also becoming reluctant to provide the subsidies for fertilizers on which the whole programme depended.

But this was not the end. Research stations and seed companies were still creating new varieties, and there were parts of the world where the technologies had not spread widely, especially in Africa. The technology is scale-neutral, in the sense that small farmers can use purchased seeds, fertilizers and sprays, not only large farmers. But it is easier for large companies to deal with a few large farmers rather than many small ones, and many small farmers do not have the resources or credit to purchase inputs. But there have been successes. Thus Rasmussen (1986) wrote of "The Green Revolution in the Southern Highlands" in Tanzania, based on improved varieties of maize (not all hybrids) and subsidized fertilizers, and since then hybrids have spread widely in the South-West of Tanzania, enabling the country to get close to self-sufficiency in maize, mainly grown on small farms.

Narratives of scarcity are used to as a humanitarian driver behind scaled up investment to ensure food security, although the form that this 'second green revolution' should take is far from agreed (Hallegatte et al., 2015). In common with the first, it seeks increases in production through external inputs of improved seeds, fertilisers and pesticides. Africa is deemed to have missed out and must catch up quickly if it is to feed all the hungry mouths. In 2016 Dawson, Martin and Sikor reported on the 'imposed innovation' being implemented by the Government in Rwanda in which small farmers were being compelled to grow hybrid maize and to abandon their traditional crops. The Government prescribes what crops farmers must grow, forcefully imposes 'modern' seeds through legislation and enforced a turn away from poly-cropping agricultural production and other techniques which lessen the risks facing small farmers and improve their diets. The authors show, on the basis of surveys in eight villages in the hill areas of Western Rwanda, that only a small percentage of wealthier farmers could adhere to the modernisation packages. A significant proportion of farmers found their production disrupted, their poverty exacerbated and their land tenure increasingly precarious. This had led to increased production of maize. It has also led to many farmers losing their land – poverty and inequality had greatly increased. The numbers of livestock had decreased, and many farmers had stopped selling the crops they previously sold. Just as with the Green Revolution in India, most of the benefits had gone to the better off farmers (Dawson et al, 2016).

The narrative thrust is little different to the familiar urge of African Ministries of Agriculture that agricultural production must be 'modernised' and 'commercialised'. This continues a theme that can be traced from colonial occupation (Poku & Mdee 2011; Coulson 2013 and 2015). Major bilateral donors (USAID, DFID) along with the new philanthropists have sought to fund the new push for agricultural transformation in Africa, with an emphasis on land tenure formalisation, access to modern inputs and export driven production (Morvaridi 2016, Westegen & Banik 2016).

Agricultural transformation is recognised in the debates on structural economic transformation as necessary for addressing climate change and facilitating environmental sustainability (Mdee et al 2016). It increases the productivity of labour, so releasing labour for industrialisation. However, there is no fixed route for this. Mechanised agricultural production practices have been developed to minimise the use of labour. These are a major source of carbon emissions, and the technologies, to the extent that they are adopted, will release far more labour than can be employed in a modern industrial sector. Thus, the path followed by the first green revolution is problematic in the current context.

However, there are other ways in which an investment and intensification of labour in small-scale farming can be a route to transformation (Mdee et al 2016, Wiggins 2016). Hence, there is now an increased focus on 'sustainable intensification' (Campbell et al 2014), and 'climate-smart agriculture' (Firbank 2012, Pretty et al 2011) within the mainstream literature, including the World Bank Shock Waves Report (Hallegatte et al 2015, Conceição et al 2016 , Holt-Giminez et al 2012). The extent to which the growing urge for the second green revolution to be built on a more climate-smart agriculture is not yet clear. One erroneous interpretation of climate-smart agriculture is an assumption that all it requires is the adoption of irrigation in the face of water shortage. Irrigation has a part to play, especially the more efficient use of water, but other changes in cultivation practices and choices of crops are more fundamental (Manjengwa et al 2014; Wiggins 2016, FAO 2016; Harrison & Mdee 2017b).

Championing the small farmer is often associated with the concept of food sovereignty. There are many definitions of food sovereignty, but here we refer to the one adopted by Via Campesina in the Nyeleni declaration of 2015[1].

'Food sovereignty is the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems '.

The idea of food sovereignty offers a more socio-political perspective on food scarcity and food systems, and provides a powerful critique to the dominant neo-liberal food regime (McMichael 2009; Ngcoya & Kumankulasingum 2016; Roman-Alacala 2016; Bush & Martiniello 2016). However, food sovereignty is also a contested concept. Its meanings are multiple (Alonso-Fradejas 2015). It is accused of being over focused on peasants and small-scale production. Further, as Agarwal (2014) argues, food sovereignty may not address more localised dynamics of distribution- such as gendered access to production resources within the family. Just as it is often unhelpful to approach agricultural transformation through the lens of small vs large farmers, so casting food security and food sovereignty as alternatives is not helpful (Clapp 2014). The science and philosophy of agro-ecology appears to have become associated with overtly political food sovereignty approaches, perhaps too much so. This allows Bernstein (2014) to suggest,

[1] Nyeleni Declaration - Available at http://www.fao.org/family-farming/detail/en/c/384351/

incorrectly, that the approach assumes that ‘peasants’ are a morally, socially and ecologically superior to other farmers and hence he dismisses its potential to transform the livelihoods of small-scale food producers.

Low-input agricultural models of production (such as agroecology) have received some, but insufficient mainstream attention, and their potential contribution to pro-poor, scientific, climate resilient and environmentally positive food production systems has up to now often been missed (IFAD 2011). However, the necessity of a more robust policy engagement with agro-ecology and other forms of low-input, low environmental impact agriculture, as a critical component of sustainable intensification, is now very pressing, for both climate change mitigation, adaptation and ensuring food security (Conceição et al. 2016).

This paper therefore attempts to address the following questions: to what extent can the adoption of the science and practice of agro-ecology enable the creation of sustainable livelihoods for currently small-scale subsistence farmers?

It is divided into three parts. The first part sets out how a conceptual framework of the application of the science and practice of agro-ecology can be integrated into a livelihoods analysis. The second part of the paper applies this framework to a case study of agroecological production in the Uluguru Mountains in Tanzania, and, through a combination of data from empirical small studies, develops a dynamic and holistic livelihoods analysis of small scale farmers. It details the methodology used in these studies and presents mixed method evidence on production, social relations, institutions and resource access. The third part of the paper presents findings of significant improvements in agricultural production and well-being in farmers who have adopted agro-ecological practices. However, these livelihoods are under threat from their perceived damaging impact on water resources, so the conclusions have implications for the relationships between farmers and the institutional bodies that mediate access to land and water.

2. The potential of an agro-ecological approach to transform agricultural livelihoods

The concept of sustainable agriculture, and the science and philosophy of agroecology has begun to receive more mainstream attention (Sillici 2014).

Altieri (1995; 2002) outlines the principles of agroecology as:

- Increasing biomass and balance in nutrient flows
- Promoting high levels of soil organic matter and an active soil biology through mulching and cover crops
- Minimising nutrient losses
- Promoting functional biodiversity- within and between species, above and below ground.
- Promoting increased biological interactions and synergies to enable pest management and soil fertility which do not rely on external inputs.

This creates an agricultural mode of production that limits external inputs and focusses on increasing soil fertility.

Studies show that farms with high levels of agroecological integration can produce higher total production per unit area with fewer off farm inputs (Altieri 2002, Monzote et al 2002, Funes-Monzote 2008, 2010, van de Merwe et al 2010, Rosset et al 2011, Pretty et al 2008, Nyantakyi-Frimpong 2016; Pandey et al 2016; Ghosh 2014, Brown 2016). In addition, a body of work confirms the productivity and viability of this production mode under the wider heading of sustainable agriculture- see Pretty 2001, 2002, 2003), as well as the environmental benefits of soil and water conservation practices (West et al 2014, Scoones 2001). Whilst many of these conclusions are drawn on the basis of small case studies, there is wider evidence that an agro-ecological approach can be transformatory on a much larger scale.

Over the past 30 years Cuba has offered something of a natural experiment. Following the collapse of the Soviet Union, a crisis of funding (the so-called 'special period') necessitated a reinvention of agriculture in Cuba, to favour low input production. This suggests that it is possible to deliver agricultural transformation with a low level of external inputs and greater cooperation and social awareness (Funes-Monzote, Rosset et al 2011, Stricker 2010). Rosset et al (2011) outline three significant findings in their study of Cuban agriculture: (1) that a social process methodology, in which groups of farmers worked together both to improve their environment and increase production, contributed to spread of agro-ecological practices; (2) that farming practices evolved over time and increased production and (3) this also produced increased resilience to climate change. Rosset et al (2011) go so far as to suggest that small-scale agriculture in Southern agroecological systems could over the long term outperform conventional monocropping in total outputs per area.

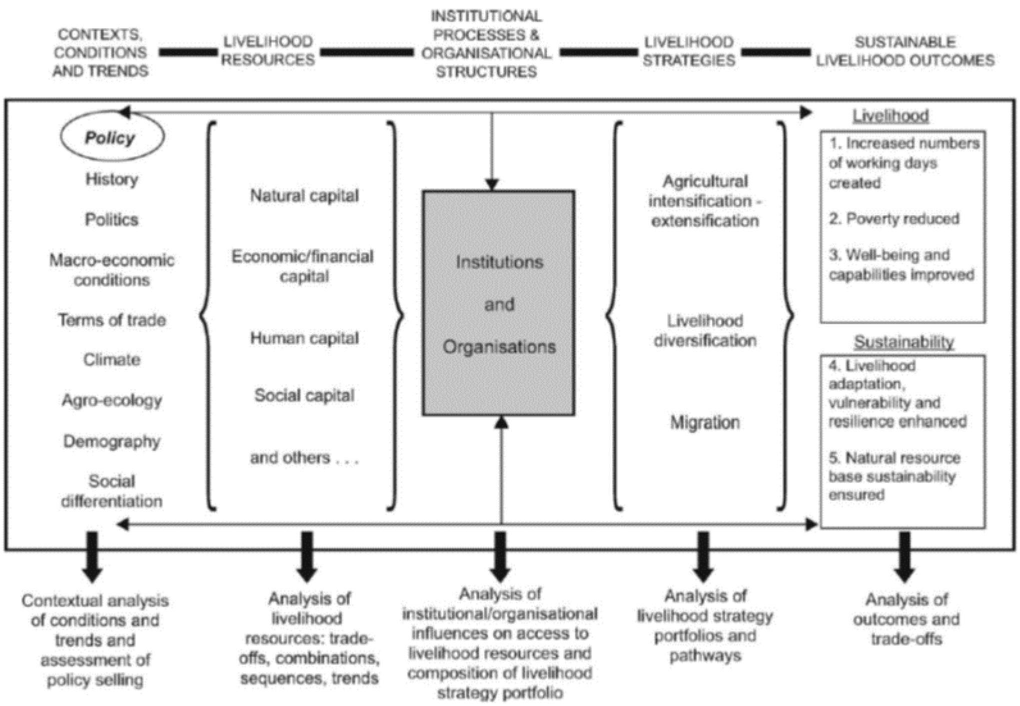
In 2013 Bhutan made a national commitment to convert to 100% organic (actually agro-ecological) agricultural production by 2020 (Neuhoff et al 2014). These large-scale commitments set alongside the small-scale project evidence of increased production with minimal or positive environmental impact, leads some to ask why wouldn't countries in Sub-Saharan Africa incorporate such approaches in agricultural policy in order to drive pro-poor and environmentally beneficial agriculture (Mdee et al 2016, Nyantakyi-Frimpong et al 2016)?

In 2010, there was a Directive from the AU Heads of State and Government a Decision on Organic Farming (Doc. EX.CL/631 (XVIII). The Summit decision requested the African Union Commission (AUC) and the New Partnership for Africa's Development (NEPAD) Planning and Coordinating Agency (NPCA) 'to initiate and provide guidance for an AU-led coalition of international partners on the establishment of an African organic farming platform based on available best practices; and to provide guidance in support of the development of sustainable organic farming systems' (IFOAM 2013:12). In practice, governments in Sub-Saharan Africa have been slow or resistant to incorporate agroecological approaches. Through research on Uganda, Isgren (2016) suggests that whilst government is paying more attention to agriculture, seeking both economic growth and poverty reduction, there is a pressure to focus on increasing the size of land holdings and in moving subsistence and small-holder farmers away from agriculture. The narratives of *modern* agriculture are very powerful and diminish low input agriculture as backward and unmodern. We observe this same narrative repeated in Tanzania (See also Mbunda 2013). Agriculture is to be modernised and commercialised, and this is perceived as incompatible with small-scale agriculture. Isgren (ibid) notes there is also a cultural pressure against the desirability of working in agriculture that prevents innovation and knowledge accumulation; and that the knowledge and labour intensity of the adoption of agro-ecological practices can be a barrier to their adoption.

What is therefore required is a greater engagement with how agroecology as both a science and a set of practices shifts and shapes livelihoods. How does the adoption of agroecology link to the operation of markets, the design of policy, the assets that people have access to and the institutions that shape them? This has been captured to some degree in Latin America (Altieri & Toledo 2011, Altieri et al 2012; Rossett et al 2011), but much less so in Sub-Saharan Africa. To overcome the inherent prejudice towards agro-ecology (as noted above by Isgren 2016), then more detailed explanations of the transformational potential of agro-ecology are required.

Our research in Tanzania has explored the adoption of agro-ecological using the livelihoods framework outlined in figure 1. Such frameworks have been the dominant tool for understanding rural development over the past 15 years (Scoones 2009). Their strength lies in the attempt to construct a holistic and multi-dimensional assessment of how the livelihoods strategies of individuals are shaped by their access to assets, their social, political, economic and environmental context, and by the way that institutions operate.

Figure 1: Sustainable Livelihoods Framework (Scoones 2009: 177)



This framework makes it possible to analyse the incorporation of an agro-ecological approach into an existing livelihoods system, and to highlight the potential benefits, institutional dynamics and potential challenges.

Our livelihoods analysis is set out under five headings in order to explore the adoption of practices of agroecology in Tanzania:

1. Contexts, conditions and trends

How have livelihoods evolved in the locality? What are the geographic, climatic, social, economic and political factors that shape livelihood patterns? How did the science and practice of agroecology fit into this context?

2. Livelihood resources

What resources do different individuals and groups have that are used to build livelihoods. How have these changed over time? Which resources are overused and which resources exist but are not fully utilized? Which resources are absent entirely? How was agroecology adopted, and implemented? What barriers and dilemmas were faced in the process?

3. Institutional processes and structures

How do institutional patterns, rules, laws and policy influence the shape and nature of livelihoods? How was the adoption of agroecology shaped by institutional processes and structures?

4. Livelihood strategies

What are the strategies that people use over the longer term to both survive and to meet the demands of wider kin and social groups? What has influenced these changes? Have livelihoods strategies changed through the adoption of agroecology?

5. Livelihoods outcomes

To what degree are livelihood strategies able to be sustainable- that is can they meet household needs, improve well-being and enhance capabilities without depleting or damaging the natural resource base? To what extent can agroecology offer potential improvements in well-being, and environmental benefit? How sustainable are the livelihoods that have incorporated it into their strategies?

These questions raise issues about the role of knowledge, politics, scale and dynamics in shaping the livelihoods outcomes and make it possible to continue the process of framing a new research agenda around agricultural transformation through agroecology.

3. Agro-ecological production in the Ulugurus- inclusive green transformation?

This section draws on data from four recent empirical research studies which investigate livelihoods in the Uluguru mountains on the Morogoro river catchment. We use these studies to attempt a complex livelihoods analysis. The frame of this analysis is on the adoption of agroecology within livelihoods strategies and the outcomes that this has for local livelihoods strategies and outcomes.

- Anna Mdee conducted an anthropological study of the Choma area, in the mountains above Morogoro town, from 2013-14, as part of research on small-scale irrigation. Working with local researchers, she conducted a structured survey of 115 individuals, and extended interviews with 60 farmers. She also interviewed key informants in local NGOs, Sokoine University of Agriculture (SUA), Wami-Ruvu River Basin Office (WRRBO) and

Morogoro Urban Water and Sanitation Authority (MOROUWASA). This work is published in Mdee et al 2014, Mdee 2017, Harrison & Mdee 2017a, 2017b.

- Alex Wostry conducted a participatory study with 30 farmers, 19 female and 11 male, in Ruvuma, Choma and Tulo in the Morogoro River watershed in 2013. All were small-scale farmers who produce for home use and sell the surplus at the local market. They had received technical support from Sustainable Agriculture Tanzania (SAT), a local organisation focusing on sustainable solutions for small scale farmers with strong links to the Sokoine University of Agriculture. and were aware of the technologies of terracing, making compost and producing liquid fertilizer and botanical pesticides. The extent of their experiences differed from village to village. The Ruvuma farmers had practised agroecology for three years, and were "certified organic producers". The Choma farmers had received trainings for almost a year and a half and aimed to become certified producers by 2014. The Tulo farmers were being trained by Ruvuma farmers through a farmer to farmer project, but at the time of the none of them had experience in agro-ecological agriculture for less than five months. More details on this research can be found in Wostry 2014.

- Research by Chie Miyashita (2015) (Sokoine University of Agriculture) of farmers from the Ulugurus and surrounding low land areas. This included a quantitative survey of 160 agro-ecological farmers (purposively selected on the basis of their farming practice in 20 villages) and 164 comparison farmers (randomly selected from 4 of the 20 villages), which explored costs and benefits of production. Efforts were made to ensure the sample was comparable between plot size and location. It was supplemented with qualitative interviewing of a smaller sub-sample of the surveyed farmers.

- SAT End of Line survey and evaluation of the Bustani ya Tushikamane Project (2009-2016), in the Ulugurus and in the low land areas surrounding Morogoro, of which Wostry (2014) deals with a sub-sample of upland farmers. A total of 329 farmers were interviewed, 61% women.

4. Contexts, conditions and trends

The Uluguru Mountains, about 120 miles inland from Dar es Salaam, form part of the Eastern Arc Mountains in Tanzania. Like the Usambara and Pare mountains further North, the slopes are steep and the soils of moderate fertility. The rainfall and temperatures of the uplands are conducive to agriculture and settlement. Meteorological records suggest that rainfall on the higher slopes of the Ulugurus has increased since 1977, whilst rainfall on the plains has decreased over the same period (Mdee et al (2014). Young and Fosbrooke (1960) suggest that while some reports suggest that the Mountains were settled in the 17th century, that oral history indicated that indigenous people had been living in the area earlier, and were displaced by incoming settlers. The population increased during the 19th century when there were violent conflicts in the plains around the mountains (ibid)

The predominant residents of the Ulugurus are the Luguru ethnic group. The survey by Mdee et al (2014) found that 97% of residents in Choma were resident on the mountain since their birth. The Luguru practice matrilineal inheritance, and land is still influenced as a collective asset, with permission from the Luguru clans being required in cases of purchase or transfer (Young & Fosbrooke 1960; Jones 1996; Wostry 2014). Jones (1999) notes that there is relatively little gendered differentiation in agricultural labour.

This research areas are close to the city of Morogoro. The steep forested Northern slopes of the Ulugurus, with forests above about 2,000m, are a significant water catchment, and feed into the Ngerengere river, a source of the Ruvu river. This river is the main source of water for the major commercial city of Dar-es-Salaam and therefore given political significance in debates over water scarcity in the urban areas (Mdee 2017). Agriculture is possible on these slopes, and since German occupation, there has been fierce debate on how the residents of the Ulugurus treat the land. For at least 80 years well back into the colonial period, it has been alleged that the Luguru farmers are causing erosion, encroaching on the forest, burning the scrub, polluting the water courses and over extracting water (Bagshawe 1930). Attempts to enforce soil conservation measures through terracing were implemented under the Uluguru Land Usage Scheme between 1947 and 1955, but a poorly implemented and under resourced scheme led to riots in some parts of the Ulugurus (Young & Fosbrooke 1960: 141-167). These riots occulted in response to enforce terrace building, to prevent erosion, and are seen as one of the seminal examples of peasant resistance to late-colonial agricultural impositions (Young & Fosbrooke, 1960; Jones 1996, 1999; Coulson 2013; compare Scott 1985).

Agricultural plots are small and fragmented, and getting more so as the population grows. In Choma, land holdings ranged in size from 0.25-7 acres. The average holding was 2.5 acres (Mdee et al 2014), 1.4 acres of irrigated land and 1.1 acres rain-fed. Most households had a mixture of plots, some irrigated and others rainfed, for the production of maize and beans. This finding is confirmed in Jones (1996), Miyashita (2015), Wostry (2014) and SAT (2016).

The Luguru have for many generations practiced irrigation with water diverted from streams into furrows, many involving stone construction, though in some areas this was banned in recent years. Over the last 15 years, in an innovation that was never overtly promoted by the government, many farmers purchased plastic hosepipes, which are much cheaper and require less maintenance than the traditional furrows, and connected them to small sprinklers, using the naturally high pressure from the steep mountain streams. This has obvious labour and efficiency advantages (Harrison & Mdee 2017a). With cool temperatures and access to irrigation water, the production of high value horticultural crops has expanded (Jones 1999). Morogoro town provides a ready market for horticultural crops, and in the case of some crops, such as strawberries, the long-distance bus routes give access to markets in Dar-es-Salaam and Arusha (Mdee et al 2014; Harrison & Mdee 2017).

Jones, writing in the 1990s, provided evidence that suggested that soil fertility had declined and environmental degradation increased as farmers were too poor to invest in soil fertility improvements measures; specifically, they could not justify using labour on terracing, and were experiencing the ‘shock’ of the removal of agricultural subsidies at that time (Jones 1999). Her analysis chimes with that of Van Donge (1992), who saw the farmers of the Ulugurus as trapped in decline. In contrast, Ponte (2001) argues that this decline is not inevitable and can be addressed through extensification, intensification and diversification, especially where market linkages are strong. Improvements in livelihoods and agricultural production are reported in Mdee et al (2014), and this is in contrast to Jones, whose fieldwork was conducted at a time when the performance of agriculture in Tanzania had been disrupted by the country’s economic difficulties, and both policy makers and academics were very pessimistic about the future of small scale agriculture (Jones 1996a, 1996b).

Through the work of local NGOs, and particularly SAT, awareness of agro-ecological methods is high: From a random sample of 115 farmers in Choma village 85% of the farmers practice conservation tillage, and 84% use compost or manure. 53% say that have learnt these methods from the NGOs (Mdee et al 2014).

Farmers certified as organic through the SAT facilitated participatory guarantee (PGS) scheme report significant improvement in their livelihoods (Wostry 2014) and we will explore this further below. So should we conclude that this is success? That agricultural livelihoods are improving and that the positive uptake of agro-ecological practice offers an example that could be adopted more widely? This is only half the story. The water use of the Luguru farmer’s is in the eyes of the state, illegal; and the Luguru continue to be blamed for land degradation, polluting the water courses and for contributing to water scarcity in rapidly growing urban Morogoro. An effort to evict the farmers failed in 2006/7 but their livelihoods remain under threat.

5. Livelihood resources

The apparently successful uptake of agro-ecological agricultural practice and the subsequent improvement in livelihoods outcomes (addressed in the section appears to come from four key livelihood resource factors:

Some of the farmers were formerly heavy pesticide and fertilizer users. Many others were already doing low input agriculture, because they could not afford to purchase inputs of seeds and fertilisers. For them the adoption of techniques such as compost making, making pesticides and fertilisers from locally available biological sources has low financial barriers. This approach enabled them to build on, extend and value existing local knowledge, as well as relevant practices that might be dismissed as 'unmodern'. Acceptance of an agro-ecological approach has spread quickly from farmer to farmer, and through the use of demonstration plots; as the knowledge has relevance, and low barriers to adoption. Miyashita's data, summarised in Table 1, illustrates the relatively low use of chemical fertilisers and pesticides for all farmers in the study. Only 21.3% of the comparison group of farmers use chemical fertilisers and pesticides.

Table 1: Farming practices (adapted from Miyashita 2015)

Farming practices	Agro-ecological farmers (n = 160) (%)	Comparison farmers (n = 164) (%)
Organic fertilizers	90.0	35.4
Organic pesticides	71.9	3.0
Crop rotation	81.9	25.6
Mulching	81.2	19.5
Terracing	63.1	34.1
Intercropping	75.0	74.4
Cover crops	88.8	78.0
Chemical fertilizers	13.8	21.3
Chemical pesticides	13.8	21.3

Farmers were also very receptive to agro-ecological knowledge as practice as is illustrated by the following quotations (from Miyashita 2015):

"We do not need to struggle in farming shops to purchase inputs when we can make our own." (Old woman in Kauzeni)

"We used to see weeds as functionless and throw them away. Surprising enough they have their role (for fertilizers)." (Old woman in Ruvuma)

Farmers also observed improvements in the quality of their crops:

“When I harvested carrots which were grown with chemical pesticides, the carrots used to become rotten. But they do not now.” (Old woman in Ruvuma)

“When we used agro-chemicals, plants used to become bad in summer season. They turn to yellow colour. But after starting organic farming with fertilizer of animal manure, plants are okay even under strong sun. They grow well. Moreover, vegetables do not get so many diseases as many as they used to have when we used agro-chemicals.”(Old woman in Ruvuma)

Some Farmers also expressed concerns for family health from the consumption of crops treated with pesticides:

“When we started organic farming as a group, I made one of my farms as an organic farm for family uses, because I want my family to eat non-harmful food. I left other farms as conventional for commercial uses”. (Man in Ruvuma)

Concerns relating to excessive pesticide use in commercial production in Tanzania are also noted in Ngowi et al. (2016)

I. the strong social ties and embedded resource sharing arrangements in this area promote the spread of knowledge; and also, support labour requirements for labour intensive activities such as terrace building. The ethnographic research by Mdee et al (2014) highlights the management of water resources for irrigation through co-operative social and kin relationships. Terrace building, once resisted as a colonial imposition, has now been adopted in certain places where the soil is deep enough (Temple 1972, quoted by Jones 1999) as a key technique to improve long-term soil fertility improvements (Wostry 2014). Whilst farmers experience a fertility and productivity decline after initial terrace building, they can see increased productivity in the second and third years. The risks are also reduced through observing the experiences of relatives and neighbours (Wostry 2014, Mdee et al 2014).

II. Increased imports of cheaper plastic household and agricultural goods have changed the access of farmers to some types of technology. Plastic hosepipes and sprinklers have enabled a technological transformation in irrigation, and spread quickly, especially after the banning of furrow irrigation approximately 10 years ago (See Mdee 2017, Harrison & Mdee 2017 for more details on this). Farmers also occupy an advantageous hydrological position at the top of the water course, therefore they have access to water for irrigation throughout the year.

III. Expanding market opportunities have underpinned improved livelihood prospects. Proximity to the urban environment allows more possibilities for the sale of horticultural crops, with strawberry and other berry production being particularly profitable (Mdee et al 2014). SAT supports a participatory guarantee system for organic certification, which enables some farmers to supply organic-labelled products to local suppliers, and to SAT’s own shop (Wostry 2014). However, organic-labelled produce does not necessarily attract a price premium in the local market. Table 2 shows the comparative advantage in terms of market availability for the agro-ecological farmers (43% have a reliable market as opposed to only 8.5% of the comparison farmers). In addition, the considerable agricultural knowledge resources are available in the area due to the proximity of Sokoine University of Agriculture (SUA).

Table 2: Market access (Adapted from Miyashita 2015)

Market engagement	**Response**	**Agro-ecological farmers (n =160)**	**Comparison farmers (n = 164)**
Whether they have a reliable market	Yes	69 (43.1%)*	14 (8.5%)*
Whether they have a contract with trader/buyers	Yes	12 (7.5)	0 (0)
How often they go to a market	More than once a week	51 (75.0)	8 (57.1)
	More than once a month	14 (20.6)	1 (7.1)
	Less than once a month	3 (4.4)	5 (35.7)
Whether they have regular customers	Yes	71 (44.4)	13 (7.9)

* The numbers in brackets are percentages

6. Institutional processes and structures

The institutional context for the Luguru Farmers illustrates a tension between the socially-embedded production system of the farmers, that has successfully adopted agro-ecological methods, and the more formal regulatory structures of the Tanzanian state. Land access is relatively secure, through kin networks. On the other hand, access to water is contested (Harrison & Mdee 2017b). From the perspective of the local administration, the Luguru farmers are illegal water users, as they do not have water permits from the Wami-Ruvu River Basin Office.

In 2006/7 there was an attempt to evict them from the mountain, on the basis that they were causing environmental degradation and water shortages downstream in Morogoro. The Wami-Ruvu River Basin Office does not have the technical capacity to measure water flows in the river at the upper levels, and so it is difficult to ascertain the level of extraction by the Farmers. What is clear is that the Morogoro Urban Water & Sanitation Authority (MORUWASA) does not currently have sufficient water resources to meet urban demand throughout the year. They believe that the Farmers' water use is impacting on water availability for the urban area, and therefore Morogoro Municipal Council are under pressure to move the farmers from the water catchment. This eviction attempt was thwarted by intervention from the President, Jakaya Kikwete, but the institutional tension has persisted. Existing bye-laws were enforced to prevent farming within 60m of the water course, and in 2016 some houses in the valley bottoms were demolished on the orders of the Municipal Council. In 2017 the military used force to cut the water pipes.

The Farmers in Choma were actively resisting incorporation by the state (Scott 1985). They do not want to formalise to form a water users' association which would require them to pay fees for water access, given that they regard their own management of the water resources to be equitable and consensual. Mdee was told that the Wami-Ruvu River Basin Office would be willing to issue a permit for the multiple small hosepipe water intakes, but the farmers are suspicious. Many regard the local government as having done little to support them (Mdee et al 2014).

As was noted above, external interventions to counteract environmental degradation of the Ulugurus extend back over a considerable time period. Payment for ecosystem service (PES) approaches were recently piloted, but were ultimately unsustainable, given their dependence on donor funds (Kwayu et al 2014). Of current interventions, only those that have worked from, and in support of the existing livelihoods of the Luguru farmers have seen widespread adoption, as is evidence by Wostry (2014), Mdee et al (2014), Miyashita (2015) and SAT (2016). The identity and social cohesion of the Luguru remains strong; the importance of the clan in allocations of land and collective decision-making persists. At the same time, as for the rest of Tanzania, customary institutions have only limited and insecure jurisdiction as the formal institutions of the state overlay and co-exist with more customary arrangements (for an interesting comparison see work on Mafia Island by Caplan 2007).

The SAT supported farmer-to-farmer Bustani ya Tushikamane project has provided a locally embedded and reliable support structure to support the uptake of agro-ecological practice, and critically has also supported elements of market development eg. in relation to the PGS scheme. It has a strong vision of its own, and has sought out donors who support this vision. In the Ulugurus it has earned the trust and respect of farmers, and is gaining increasing international recognition for its methods and achievements. Wostry (2014) asserts that the increased use of agro-ecological practices could lessen the negative impact of the Farmers on the catchment. However, the positive uptake of agroecological practices and improved livelihoods of the Luguru farmers is threatened by this institutional impasse.

7. Livelihood strategies

Whilst previous research (such as Van Donge 1992; Jones 1999) found that in the 1990s Luguru farmers were struggling to make a living, this research suggests that agricultural livelihoods for those with access to irrigation water and with the adoption of agro-ecological practices are thriving. Farmers talk of producing food, free of pesticides, for their families, but now also for local and national markets (Mdee et al 2014). 91% of the farmers in the ByT project derive income from sales of their crops, and thus this remains the dominant livelihoods strategy- See table 3 (SAT 2016 data). In addition 46% of farmers, participating in the ByT project have additional income from small business activity- examples include driving motorbikes, owning a small shop or selling other products such as clay sticks consumed by pregnant women across Tanzania (see also Mdee et al 2014)

Table 3: Income source

Table 3 -Income source	(%)
Sales of crops	91
Formal employment	1
Sales of livestock and livestock products	22
Small business	46
Wages from piece work	16
Other sources (inc remittances)	5

In terms of agricultural strategies, farmers have adopted various aspects of agro-ecological practice, with the majority of farmers practicing the use of botanical extracts (as fertilisers and pesticides), crop rotation and intercropping as shown in table 4 (based on SAT 2016 data).

Table 4: Pests and Diseases management

Table 4- Pests and Diseases management	Adoption (%)
Using botanical extracts	77
Intercropping	60
Crop rotation	53
Using repellant plants	15
Using industrial pesticides	4
Using trap plants	2

Farmers also have high adoption levels of soil conservation and improvement techniques with more than 90% leaving plant residuals in the soil (Table 5- SAT 2016 data).

Table 5: Soil fertility method

Table 5- Soil fertility methods	Adoption (%)
Leaving residuals	90
Incorporating residuals in the soil	80
Applying animal manure	56
Planting legume plants	47
Using compost	45
Mulching	44
Other soil management ways	3

Only around 17% of farmers of all farmers (upland and lowland) use terracing as an erosion control method, but 50% were planting trees and 32% other cover crops to prevent erosion. For farmers in the upland areas, the adoption of terraces is 64%. The active avoidance of using fire in 82% of cases is significant, given that this has previously been a critical strategy used by farmers to clear land for cultivation (Table 6 SAT 2016 data).

Table 6: Soil erosion control measures

Table 6- Soil erosion control measures	Adoption (%)
Avoiding fire burning	82
Planting trees around the farm	50
Planting cover crops	32
Contour farming	21
Using terraces	17
Other erosion management ways	10

There is an active engagement by the farmers and SAT with the challenge of developing and extending marketing opportunities- through the participatory guarantee scheme and through a proposal for an agro-ecological certified market in Morogoro (SAT 2016 and Wostry 2014). As will be discussed below, this does not rely on certified goods being paid a premium for their status as 'organic', but is pursued on the basis that this livelihood strategy enables agriculture that is more profitable, given that it can lower the cost of inputs and improve productivity.

In addition, improvements in livelihoods are enabling farmers to prioritise expenditure on education for their children, with the aim that they are able to pursue urban-based livelihoods. This is essentially a positive migration[2] which if successful could reduce population pressure in the longer term.

8. Livelihoods outcomes

The above analysis paints a picture of Luguru farmers adopting a range of agro-ecological practices as part of diversified livelihoods strategies, and in the face of contestation over their access to and use of water. The growing urbanisation of Morogoro and wider economic growth in Tanzania provides a market for horticultural production, and this has improved the income of these farmers. As long as their water use remains problematic and contested, it is difficult to say that their livelihoods are sustainable; but this is the central aim in writing this paper. Is it possible for the Luguru farmers to improve their livelihoods and enhance the natural resource base; and for the state authorities to recognise their livelihood strategies as legitimate

All three of the empirical studies on the adoption of agro-ecological practice report improvements in livelihoods as a result of the adoption. The data from each of the empirical

[2] Personal comment- Alex Wostry

studies used in this paper suggest that agro-ecological production has had a number of significant benefits in terms of both poverty reduction, improving soil fertility, reducing environmental degradation, and even in regenerating environmental resources.

Mdee at al (2014) found farmers prioritising the efficient use of water resources, both through their co-operation, and through the adoption of hosepipes and sprinklers. Farmers reported significant livelihoods improvements, which they measure in relation to being able to purchase solar panels and pay fees for secondary school for their children. Wostry (2014) finds evidence that the terracing and the adoption of agro-ecological systems reduced the need for irrigation, through improved soil water management. 13 out of 18 farmers involved in this participatory research reported a reduction in their water demand, through improved soil management. Whilst this result might require further confirmation in a wider study, the implication is that through the spread of agro-ecological practice, water demand for irrigation can be reduced.

Wostry (2014) also found that following conversion to certified organic status, farmers' perception of their wealth had increased. In a detailed participatory study 14 out of 20 participants in Ruvuma and Choma viewed themselves as being of average status or as poor before conversion. Following conversion to agro-ecological and certified organic production, 16 out of 20 farmers perceived themselves as *rich*. One elderly female farmer in Ruvuma suggested she had moved from being very poor to being rich in the course of three years.

Miyashita (2015) reported both qualitative and quantitative data on livelihood outcomes. Table 7 suggests that the prices received by the agro-ecological farmers were higher for most crops, although the disparity in the numbers of farmers cultivating each crop makes direct comparison difficult. Table 8 also suggests higher production estimates for agro-ecological farmers, as compared to the sample of non-agroecological farmers

Table 7: Average price of 1kg of crop products sold (TZS)

Crop	Agro-ecological farmers				Comparison farmers			
	N	**Min**	**Max**	**Average**	**N**	**Min**	**Max**	**Average**
Maize	31	150	1400	526.45	40	30	750	490.02
Rice	16	100	1500	745.12	3	400	700	530
Banana	95	80	1080	304.38	7	100	450	202.00
Cow pea	13	70	2910	920.00	19	320	2000	1070.95
Pumpkins	25	114	700	304.92	19	100	1800	516.47
Chinese cabbage	53	400	2000	1241.51	8	50	1200	407.12
Tomato	44	150	1000	497.66	13	125	1800	490
Cabbage	28	70	1600	342.25	80	100	666	214.12

Table 8: Mean of estimated production from 1 ha (Kg)

Crops	Farming style	N	Mean
Maize	Agro-ecological	141	1156.3
	Comparison	162	1039.44
Cow pea	Agro-ecological	80	207.77
	Comparison	92	186.31
Pumpkins	Agro-ecological	95	409.62
	Comparison	81	261.83

These findings are reinforced through qualitative interviewing:

"*When we used agro-chemicals, if you planted maize, some of them grew well but some did not grow well. It made us to buy fertilizer to make them grow again. But organic maize grows well without that process. It gives us a lot of profit."* (Old woman in Ruvuma)

Both Wostry (2014) and Miyashita (2015) report increased profitability of production for agro-ecological farmers. This is because of the lower input costs of agro-ecological practice, but also enhanced productivity as compared to the comparison group of farmers. It should be remembered that the comparison group is cultivating with relatively low use of pesticides and fertilisers due to their high cost. So this is not a comparison of so called 'conventional' or 'modernised' production. However, what this does show is that agro-ecological adoption can improve profitability. Table 9 shows the gross income of the agro-ecological farmers to be significantly higher than comparison farmers, and their costs to be significantly lower. As table 10 illustrates- this necessarily increases profitability- from Miyashita (2015).

Table 9: Gross income and costs

Variable described	n	Min	Max	Mean
Gross income of agro-ecological farmers	160	0	56005000	1842657.20
Gross income of comparison farmers	164	0	17255000	378872.99
Total costs of agro-ecological farmers	160	0	1269000	206049
Total costs of comparison farmers	164	0	2382500	231902

Table 10: Profit (TZS) of production

Framing group	n	Min	Max	Mean	F	Sig.
Agro-ecological farmers	160	-391000	54736000	1636608.14	13.652	0.000*
Comparison farmers	164	-1879000	16625500	146970.55		

*significant at 0.001 level

Wostry (2014) also shows this this to be the case even when taking into account the higher labour costs associated with some agro-ecological practices, such as making pesticides from botanical extracts. Wostry (2014) finds that 19 out of 20 farmers have experienced an increase in productivity of 10% or more after one year of adoption. After three years, 9 farmers from Ruvuma observed productivity increases of an average of 43%.

Mdee et al (2014) also confirm reported high profitability in the production of the Uluguru farmers, and in this case they compare this to the much lower profitability of a highly subsidized USAID supported rice irrigation scheme at Dakawa (See Harrison & Mdee 2017b for more details).

Adoption of agro-ecological methods has additional environmental benefits. Table 5 and 6 above show the wide spread adoption of soil fertility and improvement measures, and the very significant number (82%) of farmers who no longer use fire as part of their land clearance cycle.

"*We used to fire farms. Now we know that there are good microorganisms and we stopped using fire*." (Middle aged woman in Kauzeni)

In Wostry (2014) 95% of the farmers stated they no longer use the "slash & burn" principle which contributes to soil erosion and release of carbon dioxide, compared to 90% of farmers using it before switching to organic agriculture. Soil fertility enhancements and erosion control measures in theory improve the water retaining capacity of the soils and prevent soil loss from the steep hillsides. They are also encouraging the planting of trees and cover crops. In addition, the avoidance of pesticides and chemicals avoids pollution of the water course, although the use of uncomposted animal manure could pose an issue with run-off. Further research on these aspects of the production cycle will be vital in fully understanding the impact of the adoption of agro-ecological methods by farmers. Farmers increasingly view themselves as environmental stewards and have recently interacted (facilitated by SAT) with the local government stakeholders who were previously seeking their removal.

9. Conclusion

Our research demonstrates that the introduction and spread of agro-ecological practices in the Uluguru Mountains (and the surrounding lowland) is possible, and that for farmers who adopt the practices this can lead to improvements in their livelihoods, through increased production and lower input costs. We also find evidence of beneficial impacts for reduced harm to the natural environment. These findings confirm those of others detailed in section 2, that agro-ecological practice can increase production whilst reducing environmental impact.

However, our analysis reveals that there are critical institutional barriers that will need to be overcome. The success of the farmers in the Ulugurus is partly connected to the accessibility of water for irrigation of higher-value crops, and fairly equal and homogenous social relations which have facilitated access to land and water sharing arrangements. Yet the water use of the farmers is contested and is currently considered illegal. This fundamentally threatens the longer-term sustainability of livelihood gain.

The specific context of resource and market availability underpins the successful adoption of agro-ecological practice. Hence, we cannot conclude that these practices would work as well in other contexts. One of the significant benefits of agro-ecology to poorer small scale farmers is the low cost of inputs

Such practices are knowledge intensive, and so will require inputs of time. Again, in the context of the Ulugurus, high levels of social trust and co-operation underpin the spread of agro-ecological practice. This appears to be similar to evidence from Cuba on the spread of low-input agro-ecological systems (Rosset et al 2011).

We argue that the potential of agro-ecology requires further experimentation, and it would be a relatively low risk strategy to adopt this approach into national policy. Tanzanian agricultural history is littered with examples of failed 'modernisation', and yet the small-scale farmer has continued to feed the nation. A national agricultural policy centred on increasing the application of agro-ecology practice could have a significant impact on improving agricultural production and protecting and enhancing natural resource use. With the growing demands for climate smart agriculture and sustainable intensification, Tanzania could be a world leader in adopting agro-ecological practice.

References

Agarwal, B. (2014) Food sovereignty, food security and democratic choice: critical constraints, difficult conciliations, *The Journal of Peasant Studies*, 4:6, 1247-1268

Alonso-Fradejas, A. (2015). Anything but a story foretold: Multiple politics of resistance to the agrarian extractivist project in Guatemala. *Journal of Peasant Studies*, *42*(3-4), 489-515.

Altieri, M. A. 1995. *Agroecology: the science of sustainable agriculture*, Boulder: Westview Press.

Altieri, M. A. 2002. Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems and Environment*, 93: 1–24.

Altieri, M. & Toledo, V. (2011) The agroecological revolution in Latin America: rescuing nature, ensuring food sovereignty and empowering peasants, *The Journal of Peasant Studies*, 38:3, 587-612, DOI: 10.1080/03066150.2011.582947

Altieri, M. A., Funes-Monzote, F. R., & Petersen, P. (2012). Agroecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty. *Agronomy for Sustainable Development*, *32*(1), 1-13.

Bagshawe, F.J. (1930) Land Development Survey Third Report 1929-30, Uluguru Mountains, Eastern Province: Part I. Tanganyika Territory, Department of Agriculture.

Bennett, M., & Franzel, S. (2013). Can organic and resource-conserving agriculture improve livelihoods? A synthesis. *International journal of agricultural sustainability*, *11*(3), 193-215.

Bernstein, H., 2014. Food sovereignty via the ‘peasant way’: a sceptical view. *Journal of Peasant Studies*, *41*(6), pp.1031-1063.

Brown, T. (2016) Civil society organizations for sustainable agriculture: negotiating power relations for pro-poor development in India, *Agroecology and Sustainable Food Systems*, 40:4, 381-404, DOI: 10.1080/21683565.2016.1139648

Bush, R., & Martiniello, G. (2017). Food Riots and Protest: Agrarian Modernizations and Structural Crises. *World Development*, *91*, 193-207.

Campbell, B.M., Thornton, P., Zougmoré, R., Van Asten, P. and Lipper, L. (2014) ‘Sustainable intensification: What is its role in climate smart agriculture?’ *Current Opinion in Environmental Sustainability* 8: 39–43.

Caplan, P. (2007). Between Socialism & Neo-Liberalism: Mafia Island, Tanzania, 1965-2004. *Review of African Political Economy*, *34*(114), 679-694

Clapp, J., 2014. Food security and food sovereignty: Getting past the binary. *Dialogues in Human Geography*, *4*(2), pp.206-211.

Conceição, P., Levine, S., Lipton, M., & Warren-Rodríguez, A. (2016). Toward a food secure future: Ensuring food security for sustainable human development in Sub-Saharan Africa. *Food Policy*, *60*, 1-9.

Coulson, A.C. (2013)

Coulson, A.C. (2015)

Dan-Azumi, J. D. (2016) African smallholders and agricultural hybridization', *International Journal of Agriculture and Forestry* 6(2): 86–92.

Dawson, N., Martin, A. & Sikor, T. (2016) Green revolution in Sub-Saharan Africa: Implications of imposed innovation for the wellbeing of rural smallholders, *World Development* 78(2016): 204-18

FAO (2016) *Family farming: Meeting the zero-hunger challenge*. Rome: Food and Agricultural Organization FAO.

Funes, F. 2002. *Sustainable agriculture and resistance: transforming food production in Cuba*, Oakland: Food First.

Funes-Monzote, F. R. 2008. *Farming like we're here to stay: the mixed farming alternative for Cuba*, PhD thesis, Wageningen University. Available from: http://edepot.wur.nl/122038

Firbank, L.G. (2012) 'Commentary: Pathways to global sustainable agriculture', *International Journal of Agricultural Sustainability* 10(1): 1–4.

Ghosh, S. (2014) Measuring sustainability performance of local food production in home gardens, *Local Environment*, 19(1):33-55

Hallegatte, S., Fay, M., Bangalore, M., Kane, T., Rozenberg, J., Vogt-Schilb, A., Narloch, U., Bonzanigo, L. and Treguer, D., 2015. *Shock Waves: Managing the impacts of climate change on Poverty*. World Bank Publications.

Harrison, E. & Mdee, A. (2017a) Successful small-scale irrigation or environmental destruction? The political ecology of competing claims on water in the Uluguru Mountains,Tanzania, *Journal of Political Ecology* 24(2017)406-24

Harrison, E. & Mdee, A. (2017b) Size isn't everything: narratives of scale and viability in a Tanzanian irrigation scheme, *Journal of Modern African Studies* 55(2) doi:10.1017S0022278X17000027

Holt-Giménez, E., Shattuck, A., Altieri, M., Herren, H. and Gliessman, S. (2012) 'We already grow enough food for 10 billion people… and still can't end hunger', *Journal of Sustainable Agriculture* 36(6): 595–98.

IFAD (2011). *The State of Food Insecurity in the World 2011: How does international price volatility affect domestic economies and food security*. International Fund for Agricultural Development

IFOAM (2013) *Productivity and Profitability of Organic Farms Systems in East Africa*, International Federation of Organic Agricultural Movements Available at http://www.ifoam.bio/sites/default/files/page/files/osea_ii_oa_prod_prof_report_final.pdf

Isgren, E. (2016) No quick fixes: four interacting constraints to advancing agroecology in Uganda, *International Journal of Agricultural Sustainability*

Jones, S. (1996). Discourses on land degradation in the Uluguru Mountains, Tanzania: evolution and influences. *Journal of Rural Studies*, *12*(2), 187-199.

Jones, S. (1999). From meta-narratives to flexible frameworks: an actor level analysis of land degradation in highland Tanzania. *Global Environmental Change*, *9*(3), 211-219.

Jones, S., 2002. A framework for understanding on-farm environmental degradation and constraints to the adoption of soil conservation measures: case studies from highland Tanzania and Thailand. *World Development*, *30*(9), pp.1607-1620.

Manjengwa, J.; Hanlon, J. and Smart, T. (2014). Who will make the 'best' use of Africa's land? Lessons from Zimbabwe. *Third World Quarterly*, 35(6) pp. 980–995.

Mbunda, R. (2013). The developmental state and food sovereignty in Tanzania. In *International Conference, Yale University, September* (pp. 14-15).

McMichael, P. (2009). A food regime genealogy. *The Journal of Peasant Studies*, *36*(1) 139-169.

Mdee, A., Lemma, A. & Emmott, R. (2016) Compatible or contradictory? The challenge of inclusive structural economic and environmental transformation- Challenge Paper for Chronic Poverty Advisory Network of Overseas Development Institute http://www.chronicpovertynetwork.org/resources/2016/10/31/compatible-or-contradictory-the-challenge-of-inclusive-structural-economic-and-environmental-transformation

Mdee, A. (2017) Disaggregating orders of water scarcity - The politics of nexus in the Wami-Ruvu River Basin, Tanzania, *Water Alternatives* 10(1) 100-15 www.water-alternatives.org

Miyashita, C. (2015) *Can organic farming be an alternative to improve well-being of smallholder farmers in disadvantaged areas*? A case study of Morogoro Region, Tanzania, Unpublished MA dissertation in Rural Development, Sokoine University of Agriculture. Morogoro, Tanzania.

Morvaridi, B. (2016). Does sub-Saharan Africa need capitalist philanthropy to reduce poverty and achieve food security?. *Review of African Political Economy*, *43*(147), 151-159.

Neuhoff, D., Tashi, S., Rahmann M., & Denich, M. (2014) Organic agriculture in Bhutan: potential and challenges *Organic Agriculture* 4:209–221

Ngowi, A., Mrema, E. and Kishinhi, S. (2016) 'Pesticide health and safety challenges facing informal sector workers a case of small-scale agricultural workers in Tanzania', *New solutions* 26(2): 220–40.

Nyantakyi-Frimpong, H., Mambulu, F. N., Kerr, R. B., Luginaah, I. and Lupafya, E. (2016) 'Agroecology and sustainable food systems: Participatory research to improve food security among HIV-affected households in northern Malawi', *Social Science & Medicine* 164: 89–99.

Pandey, R., Arentano, R. Gupta, A., Meena, D. Kumar, B. and Alatalo, J. (2016) 'Agroecology as a climate change adaption strategy for smallholders of Tehri-Garhwal in the India Himalayan region', *Small Scale Forestry*. Doi: 10.1007/s11842-016-9342-1

Patel, R. (2013) The long green revolution, *The Journal of Peasant Studies*, 40 (1): 1-63

Poku, N. and Mdee, A. (2011) *Politics in Africa: A new introduction*. London: Zed Books.

Ponte, S. (2001). Trapped in decline? Reassessing agrarian change and economic diversification on the Uluguru Mountains, Tanzania. *The Journal of Modern African Studies*, *39*(01), 81-100.)

Pretty, J. (2001): Policy and Practice. Policy Challenges and Priorities for Internalizing the Externalities of Modern Agriculture. *Journal of Environmental Planning and Management*. No. 44 (2), 263-283.

Pretty, J. (2002): *Agri-Culture. Reconnecting People, Land and Nature*. London: Earthscan.

Pretty, J. (2003) Agroecology in Developing Countries: The Promise of a Sustainable Harvest, *Environment: Science and Policy for Sustainable Development*, 45:9, 8-20, DOI: 10.1080/00139150309604567

Pretty, J.; et al. (2008): Internalization of agri-environmental policies and the role of institutions. *Journal of Environmental Management*, No. 90, 175-184. 115

Pretty, J.; et al. (2010): The top 100 questions of importance to future the future of global agriculture. *International Journal of Agricultural Sustainability*, No. 8 (4), 219-236. Pretty, J.; Toulmin, C. and William, S. (2011): Sustainable intensification in African agriculture. *International Journal of Agricultural Sustainability* No. 9, Vol.1, 5-24.

Rasmussen, T. (1986) 'The Green Revolution in the Southern Highlands', in Jannik Boesen et al (eds.) *Tanzania: Crisis and Struggle for Survival*, Uppsala: Scandinavian Institute of African Studies, pp.191-205.

Roman-Alcalá, A. (2016). Conceptualising components, conditions and trajectories of food sovereignty's 'sovereignty'. *Third World Quarterly*, *37*(8), 1388-1407.

Rosset, P. M., Sos, B.M., Roque Jaime, A., Lozana, D.A.R. (2011) The Campesino-to-Campesino agroecology movement of ANAP in Cuba: social process methodology in the construction of sustainable peasant agriculture and food sovereignty, *The Journal of Peasant Studies*, 38(1),161-91

Savile, A.H, (1945) Annual report. Department of Agriculture, Tanganyika Territory 1945.

SAT (2016) End line survey – Bustani ya Tushikamane Project 2009-2016, Morogoro: Sustainable Agriculture Tanzania

Scoones, I., 2001. *Dynamics and diversity: soil fertility and farming livelihoods in Africa: case studies from Ethiopia, Mali, and Zimbabwe*. Earthscan.

Scoones, I. 2009. Livelihoods perspectives and rural development, *The Journal of Peasant Studies*, 36:1, 171-196, DOI: 10.1080/03066150902820503

Scott, James C. (1985). *Weapons of the Weak: Everyday Forms of Peasant Resistance*. New Haven: Yale University Press.

Silici, L. (2014) Agroecology-what it is and what it has to offer. *Issue Paper 14629 IIED. London: International Institute for Environment and Development IIED*

Stricker, P. (2010) Bringing social justice back in: Cuba revitalises sustainable development, *Local Environment*, 15(2)185-97

Temple, P. (1972) *Geografisca Annaler*

Ulvila, M. (1995). Learning with the villagers: An account of participatory reseach in the Uluguru Mountains. *Tansania', unpublished MA Thesis, University of Tampere*.

UN (2016) Sustainable Development Goal 12, New York: United Nations, Available at https://sustainabledevelopment.un.org/sdg12

van der Merwe, J., Cloete, P. & van der Hoeven, M. (2016): Promoting Food Security through Indigenous and Traditional Food Crops, *Agroecology and Sustainable Food Systems*, DOI: 10.1080/21683565.2016.1159642

Van Donge, J. K. (1992). Agricultural decline in Tanzania: the case of the Uluguru mountains. *African Affairs*, *91*(362), 73-94.

Wakeford, J., Lagrange, S. and Kelly, C. (2015) 'Managing the energy-food-water-nexus in developing countries: Case studies of transition governance', https://assets.publishing.service.gov.uk/media/57a08972e5274a27b20000ad/61478_EFW-Nexus-final-report-Hyperlinked.pdf

West, C., Thor, S., Nebié, A. & Kago, E. (2014) Famines are a Thing of the Past: Food Security Trends in Northern Burkina Faso *Human Organization;* Winter 2014; 73, 4; ProQuest Business Collection pg. 340

Westengen, O. & Banik, D (2016) The State of Food Security from Availability, Access and Rights to Food Systems Approaches, *Forum for Development Studies*, DOI: 10.1080/08039410.2015.1134644

Wiggins, S. (2016) *Agricultural and rural development reconsidered*. Rome: IFAD.

World Food Summit (1996), *Rome Declaration on World Food Security*

Wostry, A. 2014. An investigation of conservation measures and organic agriculture on the Uluguru Mountains. A thesis submitted in partial fulfilment of an MSc. Austria: University of Vienna.

Young and Fosbrooke (1960) *Land and Politics among the Luguru of Tanganyika*. Chicago: North-Western University Press

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