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Predictable patterns of unsustainable intensification

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ABSTRACT

To increase understanding of agricultural intensification processes over time and their sustainability, we studied dimensions of sustainability in the context of ongoing expansion of intensive, commercial mono-cropping of banana in Southwestern Uganda. In our approach we considered five dimensions of sustainability: economic, agricultural productivity, environment, social and human. We compared farming systems in 1998 and 2018 and integrated a gender lens. A total of four focus group discussions, two group interviews and fifteen individual interviews (8m / 7f) were conducted, complemented with a discourse analysis of newspaper articles. Results show that although intensification of banana production increased the average income level indicating improvement in the economic dimension, it did not yield sustainable outcomes in the other dimensions. The integrated analysis of five dimensions of sustainability illuminated aspects often neglected in assessment studies or policy-making around agricultural intensification, in particular socio-economic and gender dynamics. We further recognized that the observed local trends are part of a set of patterns that take place throughout the world. We conclude that to advance sustainable development, stakeholders should move away from the current over-emphasis on economic values prioritizing the individual, and that avoiding patterns of unsustainable development requires broadening to environmental and community values.

KEYWORDS

Sustainability; gender; rural transformation; farming systems; agri-food system; land use changes; Uganda

Introduction

A quarter of the world's population was moderately to severely food insecure in 2019 and over 700 million people faced severe poverty, most of these living in rural areas (FAO, IFAD, UNICEF, WFP and WHO, 2020; Worldbank, 2018). Since populations are still increasing, a doubling of Sub-Saharan Africa's population is expected by 2050 (United Nations, 2019), it is evident that food production must increase as well (Conway, 2012; Godfray et al., 2010). To reduce food insecurity and rural poverty, increasing food production alone is not enough; commercialization of food products also needs to

sufficiently support the livelihoods of rural populations and should not deplete and destroy natural resources along the way (Loos et al., 2014; Pretty et al., 2011). Since expanding agricultural production into 'new' formerly uncultivated areas is often not possible due to land scarcity or is undesirable, the political and scientific debate tends to focus on intensification of land already under agricultural use (Garnett et al., 2013; Godfray, 2015; Tilman et al., 2011; Tittonell et al., 2016; Van Lauwe et al., 2014). Whilst agricultural intensification has proven to be quite successful at closing yield gaps and increasing agricultural production in some areas of

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the world, it has been less effective in sustaining natural resources; two-thirds of the land in Africa is estimated to be degraded (ELD initiative and UNEP, 2015). Over the last decades, calls to render agricultural intensification processes (more) sustainable have gained prominence. Initially, the focus was primarily on reducing negative environmental impacts (Pretty et al., 2011). But with time, this expanded to encompass also social and human health dimensions (Loos et al., 2014; Musumba et al., 2017). Weltin et al. (2018) called for more integrated and interdisciplinary research on agricultural intensification processes for instance, which would take a holistic approach that couples farm and landscape scales and includes a socio-economic perspective. They specifically mentioned the importance of in-depth case studies which adopt a system perspective (Weltin et al., 2018). Tiftonnell et al. (2009) emphasized the importance of understanding the causes which render agricultural systems unsustainable through in-depth analysis. Kebede et al. (2019) and Aravindakshan et al. (2020) argued that building sustainable agricultural systems requires an understanding of the historical dynamics and drivers shaping changing local farming systems and landscapes. Although these and other sources mention people as either causal agents behind- and/or beneficiaries of- agro-ecological (development/innovation) processes associated with agricultural production, the human agency either as individual or as collective is largely neglected in studies on agricultural intensification (Fischer et al., 2020). This is problematic because the (diverse) perspectives of local women and men are essential to understanding what these processes entail in a particular context. With the objective of better understanding intensification processes over time, we developed and implemented a methodology to address the different dimensions of sustainability in the context of smallholder farming. We took a retrospective, gender-sensitive, participatory and qualitative approach for our in-depth case study in a subcounty of Isingiro district in Western Uganda. The rural space and farming systems in this area, transformed over the past two decades under the influence of the growing expansion of intensive, commercial mono-cropping of cooking banana. We specifically sought to identify patterns of socio-ecological development over different scales ranging from field and farm level to landscape from the perspective of adult women and men living in this area.

The study design responds to the call for more integrated approaches to study agricultural intensification processes that move away from focusing only on increasing agricultural production per unit of land and /or per unit of input whilst minimizing environmental impacts. Loos et al. (2014) argue for instance, that such a narrow approach does not demonstrate how human well-being is affected and that assessments should include a reference to social justice. The notion that sustainable development entails different dimensions, notably an economic, ecological and social dimension (the pillars of sustainability), is not new (Purvis et al., 2019) and has been intensively discussed in relation to agricultural development and environmental conservation (Bawden, 2012; Dillon et al., 2016; Godfray, 2015; National Research Council, 2014; Pretty, 2008; Rao & Rogers, 2006; Smith & McDonald, 1998) as well as in respect to other sectors such as industrial design (McDonough & Braungart, 2002). In our approach to study agricultural intensification processes, we consider five sustainability dimensions; next to agricultural productivity and economic performance, we discern the environmental, the social and the 'human' dimension (Musumba et al., 2017). The human dimension includes aspects of human rights and 'food security', 'human health' and 'nutrition'. We add a retrospective approach by requesting study participants to reflect on the past (20 years prior). Since we acknowledge that farming systems and people's roles and responsibilities in agriculture and rural communities change over time and are strongly gendered (Farnworth et al., 2016) we integrated a gender perspective. Our approach does justice to the implication that women's and men's experiences with intensification and their perspectives on the distinct dimensions of sustainability are likely to be different. It also adds depth to our investigations on the social dimension of agricultural intensification, which tends to be under-researched (Godfray, 2015; Smith et al., 2017; Struik & Kuyper, 2017).

Methodology

Study area

The case study was conducted in 2018 in Rugaaga subcounty, Isingiro district, western region of Uganda. Isingiro district, formerly part of the Mbarara district, is a relatively new district which

was created in 2006. Isingiro lies in the sub-region Ankole in the Western region of Uganda, bordering Tanzania in the south and surrounded by the districts of Rakai, Ntungamo, Mbarara and Kiruhura. With annual rainfall below 1000 mm, agriculture is limited by water shortages in Isingiro. Large areas are mostly unsuitable for crop production and used as extensive grazing lands for mainly Longhorn (Ankole) cattle while exogenous dairy and meat breeds or cross breeds are becoming more common as well. Lake Nakivale and the likewise named UN refugee settlement are both stretching into the North-Western territory of Rugaaga subcounty. The North-East of Rugaaga is bordering Lake Mburo National Parc in the district of Rakai. The Tanzanian border is located at 20–40 kms distance only.

For approximately 70% of the rural population of Isingiro, cooking banana cultivation is the primary if not only income-generating activity (Acord Uganda, 2010). Isingiro is recorded as the district with the highest production of cooking banana in Uganda (UBOS, 2010). More recent production data only available on sub-regional level, states 2.5 Mt cooking banana production in 2018 and a productivity of 16 t/ha for Ankole sub-region (UBOS, 2020). For this study, three villages were selected in the subcounty

of Rugaaga, a subcounty described in Kikulwe et al. (2018) as having the highest cooking banana production in the country. We will henceforth refer to these three villages as our study area.

Study design

Methods

In line with the study design, we use various social science methods, especially those rooting in sociology, anthropology, and gender studies. While addressing each of the mentioned dimensions of sustainability, these methods enable to illuminate people's observations and perceptions within the local context and the complexity of interrelations, which are difficult to capture with quantitative methods.

The study combines several sources for data collection (Figure 1) and builds on results and lessons from a case study conducted in 2015 (Rietveld, 2017; Rietveld & Farnworth, 2018) using the CGIAR-GENNOVATE methodology (Petesch et al., 2018) (Method 0, Figure 1). The first method (1) informed following rounds of data production and consists of a mapping exercise to pinpoint change and to identify changes at both landscape and farm scales between

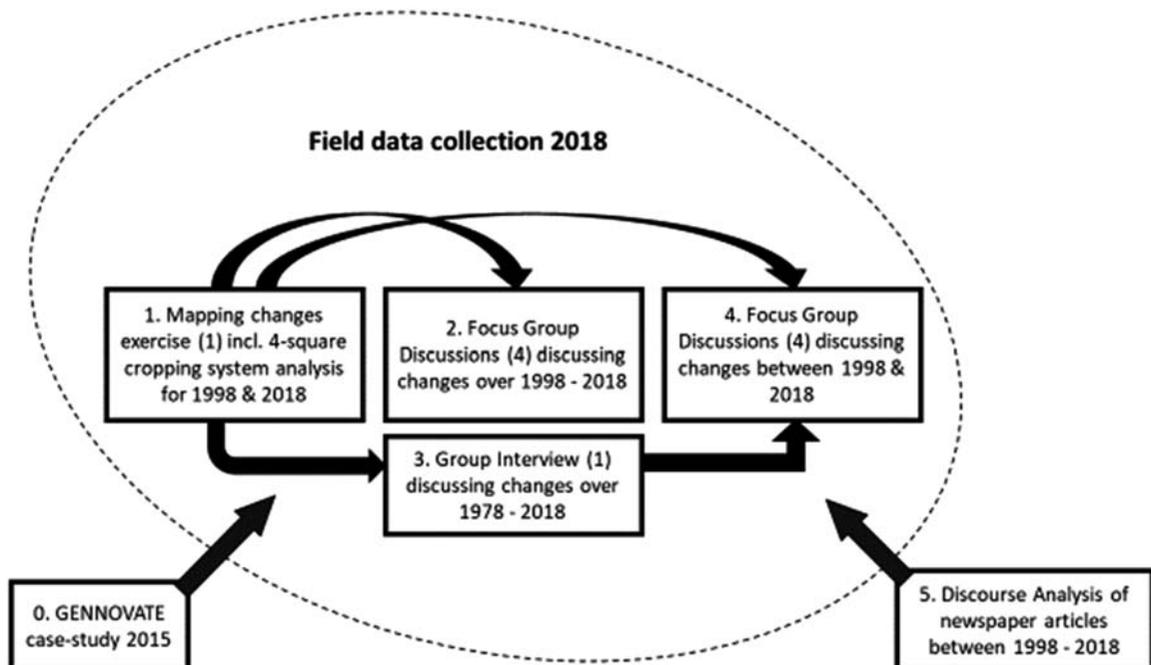


Figure 1. Flowchart of the methodology including all data sources and data collection tools used. Arrows indicate the direction in which generated data informed formulation of other methods. Between brackets the numbers of times a tool was used.

1998 and 2018. Perceptions were captured at the collective level by conducting Focus Group Discussions (FGDs) and at the individual level through semi-structured interviews. For a more in-depth understanding of the context in which these changes occurred we conducted a discourse analysis of local newspaper articles published between 1998 and 2018 describing events and trends in and for the wider geographical area where our study site was located. We also reviewed literature about the area going back to the beginning of the twenty-first century.

Method 1 – participatory mapping of changes and 4-square analysis of crops cultivated in 1998 and 2018

The objective of this exercise was to map changes in the landscape, land use and physical structures of the study area and its communities for 1998 and for 2018, to be used as an input for follow-up FGDs. We also included a participatory exercise to determine the extent and distribution of the crops cultivated in the farming systems of the community for 1998 and for 2018 which is also referred to as Extent and Distribution Analysis or a 4-square analysis (Grum et al., 2008). FGD participants first listed all the crops grown in the research area and positioned each crop in one of the four squares, based on their own subjective estimate (as defined by participants together) of the area under cultivation per farm (large/small) and the number of households growing the crop (few/many). Method 1 was conducted with two women and two men between 45 and 60 years old who had grown up in the village or moved there at a young age (>10 years). Because we required respondents to reflect on their own experiences and memories as adults back in 1998, we excluded younger people from participation. The participants were selected on basis of being respected and considered as knowledgeable people in their community.

Methods 2 and 3 – focus group discussions

The objective of the FGDs (method 2) was to collect and understand men and women's motivations to act for and in response to change within their (changing) farming systems and to identify important aspects in their assessments of the changes and their own acts and responses in relation to the dimensions of sustainability. We used the maps and 4-square cropping system analysis from method 1 as

input and means to evoke discussion. Per FGD we selected between 7 and 12 participants who lived in the community from at least 1998 onwards. Like for method 1, we set age limits on 45–60 years old. We conducted the FGDs in single-sex fashion with two groups of men and two groups of women. We further distinguished between 'wealthier' and 'poorer' sections of the population. It proved difficult to interest 'wealthier' men to participate. Some of the men initially mobilized, sent their elderly fathers on our first effort to conduct the FGD with 'wealthier men'. We responded with opportunistically interviewing these four elderly men as a group (method 3) and discussed with them changes since 1978 (rather than 1998).

Method 4 – individual semi-structured interviews

The objective of this exercise was similar to the objective of method 2 but emphasis was on individual experience and perspectives on changes of women and men farmers and focused on the changes in relation to the own life history of the interviewees. The earlier generated maps and 4-square analyses were not used in this exercise. Where appropriate, we did probe about key findings from the earlier collected data to triangulate and deepen our understanding. We conducted 15 interviews in total, with 8 men and 7 women; ages ranged between 37 and 71 years old at the time of the interview.

Method 5 – discourse analysis

About 97 newspaper articles published between 1998 and 2018 were selected for analysis. These newspaper articles were compiled from the online archive of 'All Africa' (<https://allafrica.com>) in May 2019. In the online archive a search within the 'Uganda' country archive was conducted for papers with a geographical reference to Isingiro and to Mbarara. Isingiro is the current district in which our study site is located. Before 2005, Isingiro was part of Mbarara district. The derived list was screened on relevance and selected papers were categorized in the following categories: (1) agriculture-related: land; farming; banana production; cattle (2) climate and natural resources-related: water; adverse weather; (3) population and migration-related: refugees; (4) food-related: famine.

Results

Main landscape and agricultural production changes

Comparison of the maps generated for 2018 and 1998 and the explanations of the participants indicated the following main changes: (1) large decrease in natural tree cover with no communal and/or natural forest remaining in 2018; (2) decrease in grazing land; (3) large increase in land under cooking banana cultivation; (4) large increase in human settlements and population; (5) privatization of former communal lands; (6) large decrease in cultivation of crops other than cooking banana; (7) expanded and improved road network; (8) small increase in privately owned, planted trees; (9) hillsides were increasingly bare and eroded; (10) increased access to drinking water through household water retention and creation of bore-holes; (11) increased access to electricity through grid and micro solar systems.

The Participatory Extent and Distribution Analyses (Figure 2(a,b)) illustrate the nature of the cropping system for 1998 and for 2018. Crops which were commonly grown in the community were listed by participants and divided over one of the four squares on basis of (1) the number of households growing the crop (few/many) and (2) the area under cultivation per farm (large/small). The exercise initially evoked discussion on land sizes rather than on crops. Participants in all FGDs argued that compared to 1998, with the exceptions of a few very wealthy farmers, no crops were cultivated in 2018 on large size lands because 'large land' does not exist anymore. This is reflected in Figure 2(b); although cooking banana production increased significantly it was not placed in square 1 (cultivated by many farm households on large land area) for 2018. All groups did agree unanimously that the trend consisted of increasing cooking banana production and decreasing production of other crops – de facto most households specialized in commercial cooking banana production. Moreover, they stopped intercropping cooking banana with other crops and rather cultivated cooking banana as monoculture.

Although cooking banana was also a common crop in 1998 with mostly around 0.5 acres per household, the FGD participants explained it was meant for household consumption only or to pay refugee farm workers in kind for their work. Banana plantations in 1998 usually supported a mix of cooking (1/3) and

beer types (2/3) and were commonly intercropped with annuals such as a bean. Commercial cooking banana production increased from the year 2000 onwards. This was supported by intensive extension campaigns to improve banana management starting in 2004. This raised not only the productivity but also raised bunch size which made the produced banana more attractive for traders. In the course of a few years (2005–2010) households replaced beer-banana types for cooking types and expanded cultivation at the cost of annual crop production (finger millet, roots and tubers) and grassland.

Participants stated that both the two most important crops in 1998 (square 1; cultivated by many farmers on large land area), beer-banana (*Musa spp.*) and finger millet (*Eleusine coracana*), were hardly grown anymore in 2018. Beer-banana used to be the main source of income as the raw banana was processed into beer and sold to the refugee population of Nakivale camp and to others. The cultivation of sorghum was directly linked to that of beer-banana as it serves as an ingredient of the beer. The decline of beer-banana cultivation therefore also led to the decline of sorghum cultivation.

Finger millet used to be a major food crop and played an essential role for maintaining food security throughout the year as the grains would be stored in granaries. Participants argued that finger millet largely disappeared in favour of cooking banana which is more profitable. In one of the women's FGDs, the participants argued that maize was nowadays favoured over finger millet as food crop since maize can be processed into flour (posho) by machines whilst finger millet needs to be ground manually. Nevertheless, maize is placed in square 4 (cultivated by few farm households on small land area) (Figure 2(b)).

Cassava, sweet potato, potato and pea moved from square 4 (cultivated by few farm households on small land area) to square 2 (cultivated by many farm households on small land area) indicating that cultivation of these crops became more common in 2018 than it was in 1998. Although these crops were placed in square 2 together with cooking banana, bean and groundnut, the relative importance of all the crops was still described as very different. From the FGDs it became clear that more land was allocated to cooking banana alone, than to all other crops together.

Vegetables, fruit, yam, maize and pumpkin remained in square 4 (cultivated by few farm households on small

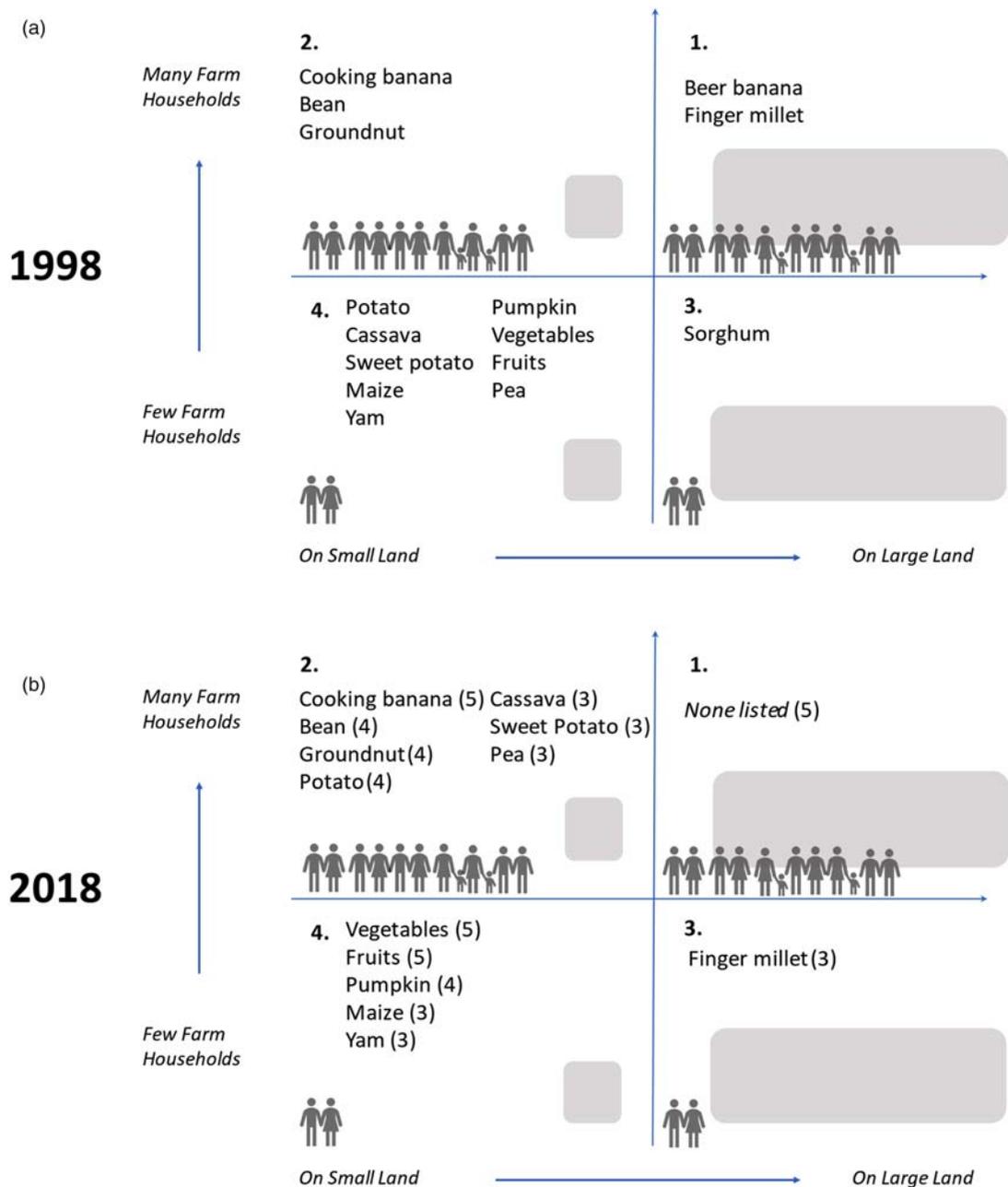


Figure 2. (a) Combined results of five Participatory Extent and Distribution Analyses for 1998; FGD participants list and categorize crops cultivated on basis of two subjective measures; (1) was the crop cultivated by many or few farm households in the community? And (2) was the crop cultivated mostly on a small land area or on large land area? All crops included were categorized alike in all five FGDs. (b) Combined results of five Participatory Extent and Distribution Analyses for 2018; FGD participants list and categorize crops cultivated on basis of two subjective measures; (1) was the crop cultivated by many or few farm households in the community? And (2) was the crop cultivated mostly on a small land area or on large land area? The minimum threshold for including crops was three times mentioned in the FGDs; between brackets number of times the crop was mentioned out of five FGDs.

land area) but participants did indicate that production volumes had reduced over time in favour of cooking banana production. Fruit trees, for instance, were

mostly cut down in favour of cooking banana production. Moreover, the diversity within the 'vegetables' and 'fruit' groups was said to have decreased.

The map of 1998 showed the presence of grazing land reserved for tending livestock. We learned that many people used to keep goats, sheep and cattle. Sometimes these grazed on privately owned land, but more often on open access private or communal lands in the surroundings. At night, the livestock would be kept in a kraal. In 2018, only few livestock were kept on the farm and in the study site as a whole, mainly as a result of lack of grazing land. Wealthier farmers owned cattle but kept these animals elsewhere where land was cheaper. Local by-laws prescribed that chicken could not roam freely because they could disturb the mulch in banana plantations, therefore only few people kept chickens and enclosed as required.

Social and economic changes

Data from both male and female FGDs further highlighted the following social and economic changes:

1. Market economy, labour markets and agri-food trade have become well-established and common:

The participants narrated that in 1998, the communities in the study area were isolated; roads were bad and transport options to urban centres were minimal; households lived scattered around the area at a distance from each other. Marketing opportunities for agricultural produce were irregular and concentrated on selling banana-beer and goats to the refugee population in the nearby Nakivale refugee camp. Traders in agricultural produce would only occasionally visit these areas for instance in search of beans or potatoes. Farm workers mostly belonged to the refugee population and would be paid in kind. Households hardly had access to cash or income-generating activities and farming was mostly oriented towards subsistence.

This changed from around 2000–2004 onwards; A government-led project focused on sustainable development, started promoting several livelihood enterprises amongst others on ‘improved cooking banana management’. This coincided with a growing demand for cooking banana from urban centres and a rise of cooking banana prices coupled with increased access because of government investment in rural roads. Increasingly, more traders came to the study sites to buy cooking banana which drove the described conversion of the cropping system and integrated farm households into the market economy.

2. Commercial cooking banana production enabled some landowners to become wealthy, resulting in a new social class of rich farmers: In 1998, there were few rich households, which was illustrated in the 1998 map by drawing only small houses and huts. The participants observed that by 2018 a new class of farmers with large landholdings had established themselves. These farmers specialized in banana cultivation with (relatively) high external input use (manure, mulch and (hired) labour). These became visible in the landscape by well-maintained large plantations and large houses of superior quality. They also took on prominent positions in newly established banana producer cooperatives and local politics. They employed large numbers of casual farm workers; both men and women originating from within and from outside of the community. Profits were invested back in banana production but also in non-farm enterprises such as real estate and retail businesses which were both established in the local trading centres and in towns such as the regional city Mbarara. This new class of rich farmers was relatively small as a percentage of the population but influential and often referenced by other farmers as an example and role-model for accumulating wealth through commercial banana production.

3. Gender tasks and norms in relation to crop production, access to land and income generation-changed: The changes in the farming systems but also improved access to facilities and increased embeddedness in the market economy led to marked gender changes. Men were said to work more and harder in 2018 than they did in 1998 and to drink alcohol only in the evening. Men invested heavily in cooking banana plantations since 2004 and usually considered this their prime livelihood. Their typical control over banana-derived income was justified by their role as head of the household and owner of the land. Men were supposed to bear responsibility for paying their children’s school fees, household basic needs for staple foods (cooking banana or posho), salt and soap and for medical care but did not always conform.

In 1998, women used to spend a large part of each day fetching water and many were involved in livestock rearing (cattle) and processing of milk. With increased access to (drinking) water and reduced importance of cattle, these activities

hardly existed anymore in 2018. In 2018, women earned respect in the community by working hard in their husbands' banana plantation. Women continued to have responsibility to prepare food and provide for 'sauce' but encountered difficulties as their access to land for growing crops like beans and vegetables became increasingly confined. Women perceived men's tendency to prioritize banana production in monocultures as the direct cause of this development:

Men do not allow us to intercrop any other crops with the bananas. (FGD poor women)

4. Polygyny became increasingly common over the years as men, earning unprecedented income from cooking banana production, married additional wives. Women complained in the FGDs and interviews that once men get a new wife, they ignore their responsibilities towards their first wives and families. Land allocated for use to the wife was often re-distributed when men married second or third wives. As a consequence, first wives ceased to benefit from the growing income derived from cooking banana sales and overall land available per household member decreased. In the two FGDs with women, participants were very outspoken that polygyny halted development in the household.
5. Banana plantation labourers formed a new social class consisting of both local and migrant women and men with no or small landholdings. Migrants came in and could stay since the demand for labour on banana plantations was large. Some of the migrant labourers took (semi-) permanent residency in the area leading to development and growth of so-called 'trading centres' (village centres), others temporarily lived-in on the wealthy farmers' plantations. Refugees from camp Nakivale were also providing labour in 2018, although participants explained this used to be more prevalent in 1998. Earnings from casual labour varied; 5000 UGX (approx. 1.5 USD in 2018) was mentioned as an average daily wage on a banana plantation but we also heard accounts of much lower wages. Especially migrant labourers living in with their employer were observed to receive less but were often provided with food and lodging. Just like in 1998, refugees were still commonly paid in kind with small bunches of cooking banana.

6. Livestock keeping became increasingly unattainable for the less endowed because of the disappearance of communal lands: Because there was not enough grassland anymore in 2018, livestock rearing had disappeared for most people, especially for those with small landholdings. This was conceived as a threat by both men and women because the security option to diversify with livestock had disappeared:

We are forced to focus on cooking banana now, which is not good. (FGD wealthier men)

This trend also affected diets as animal protein such as milk and meat became less available.

7. Increasing land prices and land scarcity: By 2018, land had become increasingly scarce and this was a key concern for most people participating in this study. Several causes of land scarcity were mentioned; immigration most prominently. Many of the study participants had migrated from other places to this locality themselves as a child or young man/woman. Those who lived in the area for several generations acknowledged that the men had sold their abundant land on the plateaus to the newcomers (mainly Banyankole tribe) roughly between 1970 and 2000. A woman told:

Many people migrated to this area and our husbands sold most of the land back then and it was the men's responsibility because men love money. We were never involved in the agreements; we would just see our land being demarcated and later find out he had sold it. (FGD poor women)

Other immigrants (Bakiga tribe) cleared the forest in the valleys and on slopes and established themselves there as farmers. In 2018, immigrants were mostly labourers looking for (temporary) employment in the banana plantations. They arrived from other parts of Uganda and to a lesser extent from Tanzania. In 2018 land had become expensive and de facto unaffordable for most smallholder farmers and labourers.

Natural population growth was also mentioned as a key driver for land scarcity. The FGD participants indicated that most households, and certainly the polygynist, had high birth rates. It meant that the new generation would often inherit tiny, fragmented landholdings. Already most locals who have lived in the study area for several decades considered their landholdings 'small'.

There were tensions between the local community and the refugee camp Nakivale concerning land. Men said in the FGDs that the camp was 'taking away' their grazing lands. These tensions were also reported in the newspapers and reached a peak in 2017 when a member of parliament incited local men to violently grab land from the camp.

Environmental changes

In the environmental domain the following changes were identified:

1. Decreasing availability of firewood for food preparation: Participants stated that forests had been cut down over the last century and virtually disappeared in the vicinity of the study area. Some woodlots with eucalypt remained but these were privately owned and often fenced off. Women mentioned firewood scarcity as the main challenge of today:

Those days [1998] the main challenge was getting water, these days it is getting firewood. (FGD wealthier women)

They told about their struggle to find enough firewood for food preparation and that they either ate fewer cooked meals a day or prepared food with shorter cooking time.

2. Soil fertility decline was a major concern for many farmers in 2018, and several indicated that smaller banana bunch sizes were being produced because of 'over-using' the land. With the semi-permanent production mode of cooking banana, crop rotation or fallows were abandoned and since most farmers did not own livestock, they had limited access to manure for soil fertilization. Some wealthy farmers purchased manure from elsewhere but for most farmers this was not feasible because of the high monetary investment required. Chemical fertilizers were not used on cooking banana; the farmers perceived these products as 'bad' for the soil.
3. Wetland destruction and siltation of lakes and rivers: Newspaper articles reported that the Mbuho-Nakivale wetland ecosystems was drying up, contributing to the drying up of river Rwiizi as well, an important water source in Mbarara district. The wetlands of Lake Nakivale, which is bordering the subcounty, were facing encroachment from both refugees and local populations as land scarcity increased. Apart from its ecological functions and value, these wetlands fulfil an important role for water retention and year-round water

availability downstream. In addition, Lake Nakivale is silting up due to run-off soil erosion in the catchment area which includes our study site. Because of the lower water retention capacity of Lake Nakivale another lake (Oruginga) was formed in 1999 altering the landscape drastically.

4. Increased occurrence of drought and regular crop failure and famine: In the FGDs and individual interviews respondents stated that they experienced 'more sunshine' and less rains during the last decade as compared to twenty years ago. Newspaper articles from 1998 to 2018 mentioned occurrence of droughts and related crises such as food shortages, cattle starvation and famine on four occasions over the course of these two decades: in 1999, 2005–2006, 2009–2010 and in 2016–2017. Drought and associated crop failure were worrying people and not without reason. Although banana plants usually did not die in the reported droughts, they did stop producing banana bunches. When we conducted these studies in May 2018, the district was just recovering from a severe drought which had caused crisis and food shortages, even famine, during 2016–2017. Several respondents made a direct link between deforestation and drought:

We cut all trees and now we have little rain. (FGD poor men)

And this drought also instilled a fear of the future in people and an awareness that reliance on banana production alone is risky:

Most of our leaders are teaching us to use bananas to get money and educate our children. This means we have focused so much on bananas that we have destroyed our own environment and if we are not careful, we will have no more plantations 20 years from now. (FGD wealthier men)

If again we are confronted with a major drought, it will be a problem. So, I think we need other sources of income. [...] With prolonged drought however nothing can work. (Individual interview male farmer).

Human dimension changes

1. Decreasing diet quality: Dietary diversity was low and diets were more staple food focused in 2018 than they were in 1998. Many households choose to sell cooking banana and to buy posho for household consumption: We only give them [the women] the small bunches for eating at home and if it is not enough, we buy posho and feed the family. (FGD wealthier men)

The on-farm availability of food crops other than cooking banana was minimal and so was storage of food, it became rare to store food whereas in 1998 it was still common practice to store finger millet in granaries. Consumption of animal products (meat, milk, ghee) has also decreased considerably:

In 1998 we would intercrop and have a large variety of food crops; now we only intercrop on the borders of the cooking banana plantation; we have almost stopped growing crops like groundnuts, beans, peas, cassava, millet. Few women grow these crops nowadays, everything is banana. (Individual interview male farmer)

Diets also suffered from the earlier mentioned firewood scarcity as meals with shorter cooking time were preferred, implying that consumption of nutritious food crops like bean with long cooking time was reduced. Land scarcity was mentioned as a primary reason for having reduced on farm crop diversity:

We would want to plant more [different] crops, but we have limited land. (FGD wealthier men)

2. Increased access to safe drinking water: In 1998, there was only one (natural) water point in the study area which served the whole population. In 2018, there were several taps installed by government where people accessed water for a small fee; this water was however not preferred for drinking because of high sodium levels. Many households practiced water retention in 2018; they established basins to collect rainwater. This had tremendous impact on especially women and children as they used to spend a lot of time collecting water (up to 4 hours per day). Personal hygiene also improved as a direct result of increased water availability and men commented that their wives look more beautiful today [2018] than they did in 1998.
3. To educate one's children has become the norm: Since 1998, the number of both public and private schools increased in the area. Most participants indicated that their children, both boys and girls, started primary school. Public primary schools charge no education fee, but caretakers do incur costs related to uniforms, materials and lunch. Because public schools were overcrowded and of low quality, many caretakers sent their children to private schools. 'School fees' were often the largest expense of households with children which applied to both poorer and wealthier population sections as wealthier households tended sending their children to more

expensive (better) private schools. Since schooling was costly and the number of children per household was generally high, attending secondary schooling was not considered evident. The number of school drop-outs was high for both boys and girls and only few children completed secondary school.

Historical context and drivers of change

The participants of the FGDs and interviews univocally shared the perception that the land and its communities in the research area underwent enormous changes on all fronts during the period between 1998 and 2018. To situate these changes in a wider context, we constructed a timeline (Figure 3) drawing on various sources both from literature and our primary data.

At the beginning of the twentieth century, our research area was very sparsely populated. High disease pressure (malaria, sleeping sickness), dryness of the climate, 'wildness' (presence of wild animals) and isolation from other settlements were mentioned as causes (Bagenda et al., 2003; Kafureka, 1992; FGDs). This changed over the second half of the twentieth century in which the population increased. In the 1940s–1950s, colonial rule promoted settlement in these sparsely populated areas from densely populated areas elsewhere in Uganda. The early migrants were often able to acquire land free of charge or cheaply and are currently still amongst the largest landowners.

In 1958–1960, the UN refugee camp (also called settlement) 'Nakivale' was established on the south border of Rugaaga subcounty. It initially hosted Tutsis fleeing Rwanda from persecution of the newly established Hutu regime (Bagenda et al., 2003). These refugees lived in relative harmony with local populations; they traded and exchanged on a growing labour and food market (primarily for banana-beer and animal products). These first refugees were described as *'those that brought development to this area'* (group interview elderly men) and they are juxtaposed with the 'other' refugees (Hutu from Rwanda and refugees from Somalia, DR Congo and Burundi) who arrived from the 1990s onwards. These later refugees *'were no use to us'* according to elderly men (group interview) and blamed for causing and aggravating land scarcity:

our grazing land is given away for free by the government.
(FGD wealthier men)

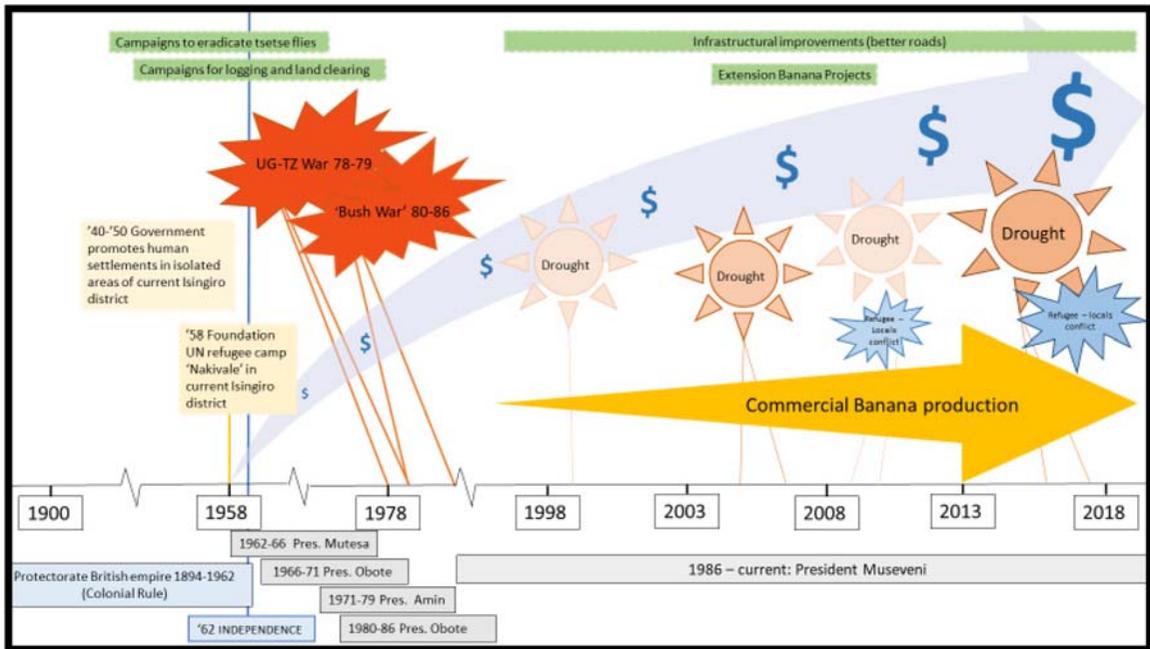


Figure 3. Timeline of events and trends relevant to our analysis. Below the timeline political leadership is shown. Above the timeline general trends: (1) Blue arrow with dollar sign signifying development of market economy, (2) Yellow arrow showing increase in commercial banana production. In green on top; political campaigns and projects which had large impact in our study area. UG: Uganda, TZ: Tanzania.

Oral anecdotes (group interview elderly men) and an FAO report (Koeman et al., 1980) indicated the implementation of campaigns to eradicate tsetse fly (vector of sleeping sickness) during president Obote's first term (1966–1971) alongside large schemes to clear forest in the valleys. This made the area more suitable for human settlement and stimulated immigration. A new wave of immigration started after the Bush War of 1980–1986 when peace and stability were reinstated after a decade of unrest. This coincided with two key trends which drove the impending investments in cooking banana production:

- (1) Renewed investment in road networks and infrastructure leading to increased connectivity to market economies, e.g. from the late 1990s onwards urban traders were enabled to visit Rugaaga to buy agri-produce;
- (2) Increased rates of urbanization and therewith the creation of large urban demand for food and particularly for the preferred staple food of the Baganda: cooking banana (matooke).

The increasing prices and demand for cooking banana stimulated the farmers to not only switch

from beer-banana cultivars to cooking type cultivars but also to decrease cultivation of other crops in favour of cooking banana and to expand its cultivation into wetlands (Adonia, 2013), woodlots, grazing lands and onto slopes. Furthermore, they intensified their banana-crop management by switching from intercropping to monoculture production and by applying more intensive management practices such as de-suckering, de-leaving and organic manure application. This intensification process was supported by government policies and extension services who actively promoted commercial cooking banana production from 2001 onwards. De facto this implied a shift in economic orientation from production for subsistence towards market-oriented agriculture:

Population increase has led to land scarcity but has also helped us to develop. We have many trading centers now, there are people to work on our farms and we have a market for our crops. (FGD poor men).

Discussion

Our discussion focuses on two points: first, we draw and discuss key learnings from our study and relate

this to current and historical rural change trajectories around the globe. Second, we reflect on and discuss these learnings in relation to agricultural research for development and possible ways out of unsustainable intensification pathways.

Predictable patterns

We learned that agricultural intensification through increased mono-cropping and use of external inputs (labor; manure) led to greater social stratification and is not attainable to poorer sections of the farming population. While household levels of wealth on average have increased as a result of intensified banana production, inequity among households and within households has also risen. At the community level, differences between the 'haves' and 'have not's' have increased as larger landholders have often managed to not only considerably increase their income but also local authority and power. They managed to secure their position by sustaining high production through large investments in soil fertility. In addition, they have often managed to diversify their livelihoods into non-farming activities which makes them less vulnerable to recurring droughts. Meanwhile, most medium and small landholders deplete their soils because they cannot afford similar investments in soil management. Simultaneously, land has been fenced off, inhibiting households with no or too little land to collect firewood or graze goats. Within households, women also tend to lose out compared to men. Although they usually spend more time on banana management than before, they often have limited control over the revenues and expenditure. In 2018, women did have more freedom compared to 1998 to cultivate annual crops which were formerly in the domain of men but their access to land had declined as more land had been brought under banana cultivation. This limited women's options to earn income from farming and to maintain diverse diets for adequate nutrition. In addition, there was a strong tendency amongst men to invest banana income in raising new and additional families (polygyny), often to the disempowerment and deprivation of first wives and all their children. This trend further reduces women's access to land and promotes land fragmentation which will increasingly put pressure on the current farming system.

The rise and growth of capitalist markets in Uganda and the increased connectiveness of our study area with this market goes a long way in

explaining the developments described by the participants in the FGDs and interviews. Not only agricultural products such as goats, banana-beer and later cooking banana were transformed into commodities, also land and labour were commodified as their economic value got established and increased. Social classes, gender relations and men and women's contributions and positions in the local society changed alongside these developments. These trends align with Polyani's (1948) description of 'The Great Transformation' and similar narratives about commodification and the transforming power of the liberal, capitalist market economy on social changes. These changes are reinforced by population growth and the associated loss of communal areas and accompanying changes in social structures (Hardin, 1968; Juo & Wilding, 2001; Lambin et al., 2001; Leopold, 1949; Norton, 2005). Intensive 'modern' farming unilaterally focused on productivity and financial profit with its associated negative externalities (Dawson et al., 2016; Pretty, 2008) can be considered as a continuation of this transformation. More recently although also not new in human history, climate change has come up as an accelerator for some of these processes (Aravindakshan et al., 2020; Farnworth et al., 2016; Lambin et al., 2001; Thompson & Scoones, 2009). More concisely we recognize in our case study, and allude to, the following familiar and predictable patterns:

1. Unequal distribution of resources and benefits: Commodity-oriented agricultural production leading to more wealth and better level of education, but wealth is unequally distributed thus leading to more inequity and women disempowerment. Resource scarcity (e.g. land, water, nutrients) increases competition and unequal distribution. These trends in unequal distribution lead to conflicts and 'wicked problems'.
2. Reduction of diversity and ecological processes: Emphasis on specialization and staple food production results in less diverse farm systems, causing for instance: (1) suppression of ecological processes such as nutrient cycling, pollination and water purification; (2) lower dietary diversity and a shift of the nutritional from scarcity to obesity.
3. Intensification-degradation spiral: Intensification of land use and inputs leads to soil degradation, necessitating more inputs, thereby aggravating degradation, resulting in a spiral of degradation.

4. Loss, depletion and pollution of resources: Expansion of agriculture for commodities leads to loss of forests, wetlands and grasslands and other shared or open ecosystems. Improved access to clean water saves time for water collection and leads to better hygiene and less diseases, but also causes depletion and pollution of the resource.
5. Increased vulnerability for volatility and change: Specialization, intensification, loss of social capital and local skills, while not investing in knowledge, redundancies, stocks and alternative options increases fragility and vulnerability to fluctuations for instance in weather conditions and resource availability.

Promise of prosperity

Participants in our case study showed strong support overall for the current mode of banana production and the expansion and ongoing intensification of production. It has brought economic gain to these communities and the predominant disposition could be paraphrased as follows: *'have you seen that very nice new house mister X build? He is a large banana producer'*. Banana production was conceived as *the* pathway to economic prosperity. Although cracks appeared in this dream after the 2016–2017 drought (see [Box 1](#)), the idea seemed persistent and farmers and politicians, especially those who benefitted from banana production most, were reluctant to acknowledge the imminent threats that (some of) the familiar patterns we describe in this paper present to local livelihoods of especially the more vulnerable in the community and to the environment. We wondered though why also poorer households, who did not seem to benefit much from this pathway, still went along with it; was it the promise of wealth and prosperity which enticed them to focus on cooking banana

production? In neighboring Rwanda, Dawson et al. (2016) identified similar developments for agricultural intensification and wealth-based inequality; of four identified household types only the people living in the two wealthiest types of households tended to benefit from agricultural intensification whilst the two poorer household types experienced more food insecurity and poverty. The difference between these two neighboring countries however is that farmers in Rwanda are prescribed what and how to grow by an authoritative regime and Ugandan farmers are not; they can make their own choices.

That said, most study participants (men, women of diverse wealth status alike) perceived the available options for adjusting and reconfiguring their individual farm system as low. A feeling of being trapped was a common denominator in their perceptions. Dogliotti et al. (2014) describe a similar situation in Southern Uruguay where family farms have intensified agricultural production in response to external trends and have become 'locked-in' on unsustainable intensification trajectories. Dogliotti et al. (2014) blame this on the kind of adjustments farmers made in response to changing conditions; these were mostly incremental in nature, and this created 'the trap' as they went along. Only through a strategic and tailored re-design of the whole farm system, a small number of selected farm households managed to turn around their individual situation. Dogliotti et al. (2014) recognized though, that ways out for especially the more resource-constrained farm households would hinge on regional-level interventions, developments and policies as well.

Fostering sustainable development

In this paper, we have gravitated towards the social dimension of sustainability in relation to agricultural

Box 1 – Climate change by increasing drought in study-area

With climate change predictions of higher temperatures and more irregular rainfall in this part of Uganda, it is likely that drought will become only more common. Wichern et al. (2019) mapped crop suitability for banana in Uganda and conclude that the area in which our research area is situated, is not suitable for banana production and water availability is the most limiting factor. That drought, and increasing occurrence and length of drought, is of large concern in the Isingiro district is also shown by Tolo et al. (2014) and by Twongyirwe et al. (2019). The latter interviewed 140 respondents from 4 different sub-counties of Isingiro. Almost all respondents conceived drought as a threat to food security in the area and had observed increases in the intensity and frequencies of droughts over the past 15 years.

intensification processes and realized that increased understanding of particularly the social dimension has a lot to offer, also in terms of understanding the drivers, underlying causes and impacts of changes linked to the productivity, economic, environmental and human dimensions. Fostering sustainable development requires an integrated, interdisciplinary, and holistic approach to agricultural intensification (Weltin et al., 2018) that makes the socio-cultural values that underly the envisioned development pathway explicit. Because sustainable development is connected to social justice, it is deeply value laden (Thompson, 2007) and tends to have cultural and moral significance. The required research approach therefore deviates from the implicitly assumed (objectivist) epistemological foundation that considers science as objective and value-free (Bawden, 2012; Cundill et al., 2012). Feminist scholars such as Longino (2005), Haraway and Harding (1993) argue that it is impossible to eliminate (all) value-driven assumptions in science and that inference by contextual values should therefore be part of the scientific endeavour (Longino, 2005, pp. 4–5). According to Longino (2005, p. 8) researchers can be committed to understanding whilst providing multiple perspectives on social and political dimensions of systems and their development as long as bias is recognized and avoided. Feminist epistemology further considers that plural perspectives are rooted in a particular context and acknowledges that these pivot around power (Anderson, 2006; Harding, 1993).

Intensification trajectories with the familiar patterns of unsustainable development as observed in our case study are associated with over-emphasis on economic values and commoditization, and the priority for the individual, as reflected in the notion of ‘methodological individualism’, the notion that the eventual unit of analysis is the individual (Norton, 2005, p. 238). Broadening the set of values to include environmental and communal values has been promoted as an approach to solve the kind of wicked problems (Rittel & Webber, 1973), we present here (Norton & Thompson, 2014). Our analysis provides a background for ‘place-orientation’; an understanding of the circumstances in which the described problems are embedded and therewith an opening to address these problems adequately through social learning (Cundill et al., 2012; Norton, 2005; Norton & Thompson, 2014). By emphasizing a focus on marginalized actors and their perspectives next to actors with

power, feminist enquiry has the potential to open the floor to diverging interests often overlooked in participatory and stakeholder processes which tend to favour more powerful actors. This focus could be embedded in a future-and community-oriented approach that supports development pathways by designing strategies and tactics based on shared economic, environmental and communal values building on shared principles and goals (McDonough & Braungart, 2002).

With regards to the question what sustainable development would look like for this community, we argue that this can only be defined by or at least together with community members (Thompson, 2007). For this to work, it is essential that also the perspectives of the non-powerful are known, considered and acted upon (Cohen et al., 2016). It is the landless farm labourers, the wives of men with only small land-holdings, the first wives of farmers who invest in second or third families, and the young men and women from large families with limited resources who are likely to benefit least and suffer most from a continued focus on agricultural intensification of commercial cooking banana and specifically its negative externalities. Sustainable alternatives will look different for different individual or groups of people (Thompson & Scoones, 2009) but need to appeal to their (broadened set of) values and provide real opportunities in order to oppose the prosperity through banana intensification promise.

Conclusions

We presented women and men farmer’s observations on and perceptions of the sustainability of ongoing intensification trends in banana production for a sub-county of Isingiro district over five dimensions; ecological, economic, social, productivity and human. The practice of thinking through all five dimensions in the assessment of sustainability of agricultural intensification processes represents a system perspective illuminating aspects directly driven by agricultural intensification which are often neglected in studies on this topic. We show how increased understanding of particularly the social dimension can support the understanding of drivers and underlying causes of changes linked to the other dimensions of sustainability in the context of smallholder farming. Through our gender lens also the distinct realities of women and men were presented which enriches this analysis of agricultural intensification processes.

The farmers participating in our case study narrated that the ongoing intensification of cooking banana production in Rugaaga subcounty has led to significant positive changes in the period between 1998 and 2018 such as increased income and improved access to water. They acknowledged however that this intensification process was not sustainable. At field level for instance, depletion of soil fertility was presented as problematic and current production levels were seen as unlikely to be maintained under similar management conditions. From a farm systems perspective, which includes a focus on the ecological, social and human dimensions of sustainability next to productivity and economic, a multitude of other negative externalities and consequences were observed. Within farming households, over-dependence on cooking banana resulted in vulnerability to droughts and malnutrition and disempowered women as compared to men. At community level, social stratification increased; a new social class built up prosperity while poor household suffered from increasingly restricted access to the resources they need to maintain their livelihoods. We recognized that the observed trends are not unique but can be observed in different shapes and on varying time-lines throughout the world. More specifically these trends lead to unequal distribution of resources and benefits; reduction of diversity and ecological processes; intensification-degradation spirals; loss, depletion and pollution of resources; and increased vulnerability for volatility and change.

Our analysis contributes to understanding of the socio-ecological system which is essential to embark on a pathway towards sustainable development. At the same time this is only a first step. Next steps to advance sustainable intensification are that stakeholders broaden their set of values to include environmental and communal values away from the current over-emphasis on economic values prioritizing the individual and that they include the perspectives of marginalized community members.

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References

- ACORD Uganda. (2010). Technical report project: "From food security to food sovereignty. Citizens and local authorities towards a new paradigm in Europe to reduce world hunger". Retrieved from <https://media.africaportal.org/documents/problems-facing-small-scale-farmers-in-isingiro-district-uganda.pdf>.
- Adonia, B. K. K. (2013). The cost of poor land use practices in Lake Nakivale wetland in Isingiro district, Uganda. *African Journal of Environmental Science and Technology*, 7(6), 448–456. <https://doi.org/10.5897/AJEST2013.1490>
- Anderson, E. (2006). How not to criticize feminist epistemology: A review of scrutinizing feminist epistemology. Retrieved from <https://www.feministes-radicales.org/wp-content/uploads/2012/03/Elizabeth-Anderson-How-Not-to-Criticize-Feminist-Epistemology-Copie.pdf>.
- Aravindakshan, S., Krupnik, T. J., Groot, J. C. J., Speelman, E. N., Amjath-Babu, T. S., & Titttonell, P. (2020). Multi-level socioecological drivers of agrarian change: Longitudinal evidence from mixed rice-livestock-aquaculture farming systems of Bangladesh. *Agricultural Systems*, 177, 102695. <https://doi.org/10.1016/j.agry.2019.102695>
- Bagenda, E., Naggaga, A., & Smith, E. (2003). Land problems in nakivale refugee settlement and implications for refugee protection in Uganda, Working Paper No. 8. Kampala, Uganda: Refugee Law Project, Makerere University. Retrieved from <http://agris.fao.org/agris-search/search.do?recordID=GB2013201225>.
- Bawden, R. (2012). How should we farm? The ethical dimension of farming systems. In I. Darnhofer, D. Gibbon, & B. Dedieu (Eds.), *Farming systems research into the 21st century: The new dynamic* (pp. 119–139). Springer.
- Cohen, P. J., Lawless, S., Dyer, M., Morgan, M., Saeni, E., Teioli, H., & Kantor, P. (2016). Understanding adaptive capacity and capacity to innovate in social-ecological systems: Applying a gender lens. *Ambio*, 45(S3), 309–321. <https://doi.org/10.1007/s13280-016-0831-4>
- Conway, G. R. (2012). *One billion hungry: Can we feed the world?* Cornell University Press.
- Cundill, G., Cumming, G. S., Biggs, D., & Fabricius, C. (2012). Soft systems thinking and social learning for adaptive management. *Conservation Biology*, 26(1), 13–20. <https://doi.org/10.1111/j.1523-1739.2011.01755.x>
- Dawson, N., Marten, A., & Sikor, T. (2016). Green revolution in sub-Saharan Africa: Implications of imposed innovation for the wellbeing of rural smallholders. *World Development*, 78, 204–218. <https://doi.org/10.1016/j.worlddev.2015.10.008>
- Dillon, E. J., Hennessy, T., Buckley, C., Donnellan, T., Hanrahan, K., Moran, B., & Ryan, M. (2016). Measuring progress in

- agricultural sustainability to support policy-making. *International Journal of Agricultural Sustainability*, 14(1), 31–44. <https://doi.org/10.1080/14735903.2015.1012413>
- Dogliotti, S., García, M. C., Peluffo, S., Dieste, J. P., Pedemonte, A. J., Bacigalupe, G. F., Scarlato, M., Alliaume, F., Alvarez, J., Chiappe, M., & Rossing, W. A. H. (2014). Co-innovation of family farm systems: A systems approach to sustainable agriculture. *Agricultural Systems*, 126, 76–86. <https://doi.org/10.1016/j.agsy.2013.02.009>
- ELD initiative and UNEP. (2015). The economics of land degradation in Africa - benefits of action outweigh the costs. A complementary report to the ELD Initiative. Retrieved from https://www.eld-initiative.org/fileadmin/pdf/ELD-unep-report_07_spec_72_dpi.pdf.
- Farnworth, C. R., Baudron, F., Andersson, J. A., Misiko, M., Badstue, L., & Stirling, C. M. (2016). Gender and conservation agriculture in East and Southern Africa: Towards a research agenda. *International Journal of Agricultural Sustainability*, 14(2), 142–165. <https://doi.org/10.1080/14735903.2015.1065602>
- Fischer, G., Darkwah, A., Kamoto, J., Kampanje-Phiri, J., Grabowski, P., & Djenontin, I. (2020). Sustainable agricultural intensification and gender-biased land tenure systems: An exploration and conceptualization of interactions. *International Journal of Agricultural Sustainability*. <https://doi.org/10.1080/14735903.2020.1791425>
- Garnett, A. T., Appleby, M. C., Balmford, A., Bateman, I. J., Benton, T. G., Burlingame, B., Dawkins, M., Dolan, L., Fraser, D., Herrero, M., Hoffmann, I., Thornton, P. K., Toulmin, C., Vermeulen, S. J., & Godfray, H. C. J. (2013). Sustainable intensification in agriculture: Premises and policies. *Science*, 341(6141), 33–34. <https://doi.org/10.1126/science.1234485>
- Godfray, H. C. J. (2015). The debate over sustainable intensification. *Food Security*, 7(2), 199–208. <https://doi.org/10.1007/s12571-015-0424-2>
- Godfray, H. C., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M., & Toulmin, C. (2010). Food security: The challenge of feeding 9 billion people. *Science*, 327(5967), 812–818. <https://doi.org/10.1126/science.1185383>
- Grum, M., Gyasi, E. A., Osei, C., & Kranjac-Berisavljevic, G. (2008). *Evaluation of best practices for landrace conservation: Farmer evaluation*. Bioversity International. Retrieved December 13, 2018, from https://www.bioversityinternational.org/fileadmin/_migrated/uploads/tx_news/Evaluation_of_best_practices_for_landrace_conservation__farmer_evaluation_1308.pdf.
- Hardin, G. (1968). The tragedy of the commons. *Science*, 162(3859), 1243–1248. doi:10.1126/science.162.3859.1243
- Harding, S. (1993). Rethinking standpoint epistemology: What is strong objectivity. In L. Alcoff, & E. Potters (Eds.), *Feminist epistemologies* (pp. 49–82). Routledge.
- Juo, A. S. R., & Wilding, L. P. (2001). Land and civilization; an historical perspective. In E. A. Bridges (Ed.), *Response to land degradation* (pp. 13–19). Oxford & IBH Publishing Co. Pvt. Ltd.
- Kafureka, L. B. M. (1992). The dynamics of the land question and its impact on agricultural productivity in Mbarara District. *Working Paper No. 25 Center of Basic Research (CBR)*, Uganda.
- Kebede, Y., Baudron, F., Bianchi, F. J. J. A., & Titttonell, P. (2019). Drivers, farmers' responses and landscape consequences of smallholder farming systems changes in southern Ethiopia. *International Journal of Agricultural Sustainability*, 17(6), 383–400. <https://doi.org/10.1080/14735903.2019.1679000>
- Kikulwe, E. M., Okurut, S., Ajambo, S., Nowakunda, K., Stoian, D., & Naziri, D. (2018). Postharvest losses and their determinants: A challenge to creating a sustainable cooking banana value chain in Uganda. *Sustainability*, 10(7), 2381. <https://doi.org/10.3390/su10072381>
- Koeman, J. H., Balk, F., & Takken, W. (1980). Chapter 2. Summary of present knowledge on the range and nature of chemical control and eradication of tsetse in Africa. In J. H. Koeman, F. Balk, & W. Takken (Eds.), *The environmental impact of tsetse control operations, a report on present knowledge*. FAO.
- Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W., Coomes, O. T., Dirzo, R., Fischer, G., Folke, C., George, P. S., Homewood, K., Imbernon, J., Leemans, R., Li, X., Moran, E. F., Mortimore, M., Ramakrishnan, P. S., Richards, J. F., & Xu, J. (2001). The causes of land-use and land-cover change: Moving beyond the myths. *Global Environmental Change*, 11(4), 261–269. [https://doi.org/10.1016/S0959-3780\(01\)00007-3](https://doi.org/10.1016/S0959-3780(01)00007-3)
- Leopold, A. (1949). *A sand county almanac. With essays on conservation from round river*. Oxford University Press.
- Longino, H. E. (2005). Can there be a feminist science? In A. E. Cudd, & R. O. Andreasen (Eds.), *Feminist theory: A philosophical anthology* (pp. 210–217). Blackwell Publishing.
- Loos, J., Abson, D. J., Chappell, M. J., Hanspach, J., Mikulcak, F., Tichit, M., & Fischer, J. (2014). Putting meaning back into “sustainable intensification”. *Frontiers in Ecology and the Environment*, 12(6), 356–361. <https://doi.org/10.1890/130157>
- Mcdonough, W., & Braungart, M. (2002). Introduction to the cradle to cradle design SM framework, version 7.02. Retrieved from <https://sitesmedia.s3.amazonaws.com/creekconnections/files/2014/12/Introduction-to-the-Cradle-to-Cradle-Design-Framework.pdf>.
- Musumba, M., Grabowski, P., Palm, C., & Snapp, S. (2017). *Guide for the sustainable intensification assessment framework*. Kansas State University. Retrieved from <https://Guide%20for%20SI%20Assessment%20Framework%20-%202010.24.17.pdf>.
- National Research Council. (2014). *Sustainability Concepts in decision-making: Tools and approaches for the US environmental Protection agency*. The National Academies Press. <https://doi.org/10.17226/18949>
- Norton, B. G. (2005). *Sustainability a philosophy of adaptive ecosystem management*. Chicago University Press. ISBN: 9780226595214.
- Norton, B. G., & Thompson, A. (2014). Ethics and sustainable development: The virtues of an adaptive approach to environmental choice. In G. Atkinson, S. Dietz, E. Neumayer, & M. Agarwala (Eds.), *Handbook of sustainable development* (pp. 105–124). Edward Elgar Publishing, chapter 7.
- Petesich, P., Badstue, L., Camfield, L., Feldman, S., Prain, G., & Kantor, P. (2018). Qualitative, comparative, and collaborative research at large scale: The genovate field methodology. *Journal of Gender, Agriculture and Food Security*, 3(1), 28–53. <https://doi.org/10.19268/JGAFS.312018.2>
- Polyani, K. (1948). *The great transformation; the political and economic origins of our time*. Rinehart.
- Pretty, J. (2008). Agricultural sustainability: Concepts, principles, and evidence. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363(1491), 447–465. <https://doi.org/10.1098/rstb.2007.2163>

- Pretty, J., Toulmin, C., & William, S. (2011). Sustainable intensification in African agriculture. *International Journal of Agricultural Sustainability*, 9(1), 5–24. <https://doi.org/10.3763/ijas.2010.0583>
- Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: In search of conceptual origins. *Sustainability Science*, 14(3), 681–695. <https://doi.org/10.1007/s11625-018-0627-5>
- Rao, N. H., & Rogers, P. P. (2006). Assessment of agricultural sustainability. *Current Science*, 91(4), 439–448.
- Rietveld, A. M. (2017). Gender norms and agricultural innovation; insights from Uganda. In I. Oborn, B. Vanlauwe, M. Phillips, R. Thomas, W. Brooijmans, & K. Atta-Krah (Eds.), *Sustainable intensification in smallholder agriculture; an integrated systems research approach* (pp. 3–5). Routledge.
- Rietveld, A., & Farnworth, C. R. (2018). *Towards gender-responsive banana research for development in the East African highlands. GENNOVATE resources for scientists and research teams. CDMX. CIMMYT.*
- Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4(2), 155–169. <https://doi.org/10.1007/BF01405730>
- Smith, C. S., & McDonald, G. T. (1998). Assessing the sustainability of agriculture at the planning stage. *Journal of Environmental Management*, 52(1), 15–37. <https://doi.org/10.1006/jema.1997.0162>
- Smith, A., Snapp, S., Chikowo, R., Thorne, P., Bekunda, M., & Glover, J. (2017). Measuring sustainable intensification in smallholder agroecosystems: A review. *Global Food Security*, 12, 127–138. <https://doi.org/10.1016/j.gfs.2016.11.002>
- Struik, P. C., & Kuyper, T. W. (2017). Sustainable intensification in agriculture: The richer shade of Green. A review. *Agronomy for Sustainable Development*, 37(39). <https://doi.org/10.1007/s13593-017-0445-7>
- Thompson, P. B. (2007). Agricultural sustainability: What it is and what it is not. *International Journal of Agricultural Sustainability*, 5(1), 5–16. <https://doi.org/10.1080/14735903.2007.9684809>
- Thompson, J., & Scoones, I. (2009). Addressing the dynamics of agri-food systems: An emerging agenda for social science research. *Environmental Science & Policy*, 12(4), 386–397. <https://doi.org/10.1016/j.envsci.2009.03.001>
- Tilman, D., Balzer, C., Hill, J., & Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. *Proceedings of the National Academy of Sciences*, 108(50), 20260–20264. <https://doi.org/10.1073/pnas.1116437108>
- Tittonell, P., Klerkx, L., Baudron, F., Félix, G. F., Ruggia, A., van Apeldoorn, D., Dogliotti, S., Mapfumo, P., & Rossing, W. A. H. (2016). Ecological intensification: Local innovation to address Global challenges. In E. Lichtfouse (Ed.), *Sustainable agriculture reviews. Sustainable agriculture reviews* (Vol. 19, pp. 1–34). Springer. https://doi.org/10.1007/978-3-319-26777-7_1
- Tittonell, P., van Wijk, M. T., Herrero, M., Rufin, M. F., de Ridder, N., & Giller, K. E. (2009). Beyond resource constraints – exploring the biophysical feasibility of options for the intensification of smallholder crop-livestock systems in Vihiga district, Kenya. *Agricultural Systems*, 101(1-2), 1–19. <https://doi.org/10.1016/j.agsy.2009.02.003>
- Tolo, C. U., Majule, E. A., & Lejju, J. B. (2014). Chapter 23 local and indigenous knowledge systems in subsistence agriculture, Climate risk management, and mitigation of community vulnerability in changing Climate, Lake Victoria basin: A case study of Rakai and Isingiro districts, Uganda. In A. M. Melesse, W. Abtew, & S. G. Setegn (Eds.), *Nile river basin, eco-hydrological challenges, climate change and hydropolitics* (pp. 451–473). Springer International Publishing. https://doi.org/10.1007/978-3-319-02720-3_23.
- Twongyirwe, R., Mfitumukiza, D., Barasa, B., Naggayi, B. R., Odongo, H., Nyakato, V., & Mutoni, G. (2019). Perceived effects of drought on household food security in south-western Uganda: Coping responses and determinants. *Weather and Climate Extremes*, 24, 100201. <https://doi.org/10.1016/j.wace.2019.100201>
- Uganda Bureau Of Statistics (UBOS). (2010). Uganda census of agriculture 2008/2009; Volume IV: crop area and production report.
- Uganda Bureau Of Statistics (UBOS). (2020). *Uganda annual agricultural survey (AAS) 2018*. UBOS.
- United Nations. (2019). Department of economic and social affairs, population division 2019, world population prospects 2019; 10 key findings. Retrieved from https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf.
- Van Lauwe, B., Coyne, D., Gockowski, J., Hauser, S., Huising, J., Masso, C., Nziguheba, G., Schut, M., & Van Asten, P. (2014). Sustainable intensification and the African smallholder farmer. *Current Opinion in Environmental Sustainability*, 8, 15–22. <https://doi.org/10.1016/j.cosust.2014.06.001>
- Welten, M., Zasada, I., Piorr, A., Debolini, M., Geniaux, G., Moreno Perez, O., & Schulp, C. J. E. (2018). Conceptualising fields of action for sustainable intensification – A systematic literature review and application to regional case studies. *Agriculture, Ecosystems and Environment*, 257, 68–80. <https://doi.org/10.1016/j.agee.2018.01.023>
- FAO, IFAD, UNICEF, WFP, & WHO. (2020). *The state of food security and nutrition in the world, transforming food systems for affordable healthy diets*. <https://doi.org/10.4060/ca9692en>
- Wichern, J., Descheemaeker, K., Giller, K. E., Ebanyat, P., Taulya, G., & van Wijk, M. T. (2019). Vulnerability and adaptation options to climate change for rural livelihoods – A country-wide analysis for Uganda. *Agricultural Systems*, 176, 102663. <https://doi.org/10.1016/j.agsy.2019.102663>
- Worldbank. (2018). Decline of global extreme poverty continues but has slowed. Press release no: 2019/030/dec-gpv. Retrieved from <https://www.worldbank.org/en/news/press-release/2018/09/19/decline-of-global-extreme-poverty-continues-but-has-slowed-world-bank>.