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Time is not always money: A preliminary study on socially sustainable strategies for banana xanthomonas wilt (BXW) mitigation efforts in Mbarara region, Uganda

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Following the Ugandan government's announcement in 2016 that banana xanthomonas wilt (BXW) disease was under control, national-level anti-BXW support dwindled to the point of leaving farmers effectively on their own to continue controlling it. This qualitative case study utilizes data from group and individual interviews, as well as observational walkthroughs of plantations, in one of the previously hardest-hit BXW regions of Uganda to explore farmer perceptions, experiences, and compliance around still-mandated anti-BXW change-behaviours in rural Uganda. Analysed through a lens of increased support for the social pillar of sustainability, the findings identified two central themes arising from inadequate or non-existent local farmer support for anti-BXW efforts in the area: (1) a socially time-prohibitive aspect of the change-mandates, and (2) an insufficient or non-existent reach of anti-BXW messaging to farmers. Discussion and recommendations for more socially sustainable pathways for messaging anti-BXW behavior-changes to Ugandan farmers are included.

Key words: Banana, banana xanthomonas wilt (BXW), Uganda, food security, sustainability.

INTRODUCTION

The aim of this paper is to explore and mitigate barriers to full adoption of banana Xanthomonas wilt (BXW) disease mitigation measures in eastern Africa (and Uganda specifically). Although officials in Uganda declared BXW under control by 2016, subsequent decreases in funding and support for continuing mitigation have led to resurgences of the disease and farmers finding themselves almost entirely on their own (Gotor et al., 2020). This issue has further given that BXW is a trans-boundary (regional) issue capable of

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crossing international borders, such that mitigation failures in one country can potentially spill over into other parts of the region (Goodman et al., 2021).

To address this aim, the authors turn in this paper from the well-documented economic impacts of BXW in eastern Africa to investigate and add to the picture of the challenges around the social pillar of sustainable development-solutions for BXW eradication. In particular, they explore how the current framing of recommendations for mitigating BXW in Uganda can fail to resonate practically and culturally with the broader social world and discourse that banana occupies in the region, leading to decreased (only partial) BXW mitigation compliance. To better secure mitigation (in light of the fact that large-scale mass commitments are unlikely to re-occur anytime soon), it can specifically be the social pillar of sustainability - more than the economic or environmental pillars - that best stands to address the challenges arising from both from efforts to change cultural banana farming practices in Uganda as well as political impacts from BXW trans-boundary issues.

Given that the lack of practical and cultural resonance with BXW mitigation solutions can result (and has resulted) in farmer noncompliance with anti-BXW measures in Uganda, such a situation decreases the effectiveness of past and on-going efforts to control it locally while increasing the likelihood of the disease's spread both within and across the Ugandan border. In particular, following the generally successful mass-scale mitigation of BXW in Uganda, which reduced the percentage of farm infestation from 50% in 2013 to 1.9% in 2015 (Gotor et al., 2020), the subsequent lack of on-going support has left banana farmers on their own to face subsequent resurgences of BXW (Gotor et al., 2020).

In as much as it seems unlikely that there will be any adequate provision of such support going forward, it becomes critical to find culturally feasible and cost-effective channels for reaching banana farmers such that fuller compliance with BXW mitigation protocols is achieved. As such, through this paper's analysis, the findings not only disclose potential alternative policies (or at least strategic wordings of policies) that better align with the broader discourse and social importance of banana for local banana farmers in Uganda but also increase the likelihood of policy compliance by people for improved control (if not elimination) of BXW both locally and therefore regionally.

Achieving the triple bottom line of sustainable development

The analytical lens of this paper is the social pillar of sustainability. Although sustainable solution-development calls for triple bottom-lining of the economic, social, and environmental gains arising from any proffered solution (Luetz and Walid, 2019), Afful et al. (2019) have correctly noted that the social pillar of sustainable development tends to remain underemphasized and vague. For example, a meta-analysis of key terms in human development reports by Luetz and Walid (2019) finds that "'economic' perspectives dominate 'sustainability' and 'social' perspectives by a factor of 2 and 4.6,7 respectively" (301). Afful et al. (2019) also highlight a continuing tendency to assume that if the economic pillar of sustainable development is addressed or supported, then somehow the social pillar of sustainable development "automatically" takes care of itself.

Because the three pillars of sustainable development are intertwined or may be difficult to distinguish from one another at times (Luetz and Walid, 2019), this complicates their measurement. For example, while economic success measures can be interpreted as evidence for social success measures (Keyes and Shapiro, 2004), ample research also demonstrates how economically motivated replacement of traditional social farming habits with industrial or monoculture farming can have not only direct, negative environmental impacts (for instance, the degrowth literature, c.f., Martínez- et al., 2010; Schneider et al., 2010), but also social ones as well (Bello-Bravo, 2020b; Mather et al., 1999; Rudel and Horowitz, 1993). As Corntassel (2008) notes, for example, "Unfortunately, what is considered sustainable practice by states comes at a high price for indigenous communities, often leading to the further degradation of their homelands and natural resources" (108).

Rather than relying on indirect economic measures to gauge social sustainability, the authors draw on the notion of social wellbeing to highlight a direct and immediate element of the social pillar of sustainability. Social wellbeing is a person's "self-report of the quality of his or her relationship with other people, the neighborhood, and the community" (Keyes and Shapiro, 2004:350). Given that such social wellbeing includes the goals of "social integration, social contribution, social coherence, social actualization, and social acceptance" (Keyes, 1998:121), then various means for achieving these goals must necessarily be sustainably present within a community to ensure their attainment.

While increased wealth sometimes affords such goals for some individuals, they can also erode and negatively impact social life generally (Errington and Gewertz, 1989). Unsurprisingly—given not only the platitude that "money can't buy happiness" but also the insight that the social is logically prior to the economic—the role that wealth plays for social wellbeing generally appears to have more to do with the social forms of activity that arise from or around it rather than the amount of it (Miñarro et al., 2021; Zelizer, 1996, 2000). For these reasons, one cannot automatically assume that the provision of financial wealth supports the social pillar of sustainability—not only because wealth can actually erode social life and communities (Desai, 2017; Errington

and Gewertz, 1989; Sandel, 2012) but also because it may be not available or is actually unnecessary in some contexts for achieving social wellbeing goals (Miñarro et al., 2021). Instead, if any proposed or implemented developmental solution fosters the key social wellbeing goals of “social integration, social contribution, social coherence, social actualization, and social acceptance” (Keyes, 1998:121), then that solution will better reflect support for the social pillar of sustainability.

Recovering the social pillar of sustainable development for addressing BXW

Understanding banana through the lens of the social pillar of sustainably requires a broader look. Economically, banana is the world’s fourth largest staple food and provides a livelihood and enhanced food security to more than 100 million people south of the Sahara (Nannyonga et al., 2015). In Uganda specifically, banana production previously accounted for 10 million tons annually, approximately 80% (or $440 million) of the total economic output at the crops’ average of farm price, and 22% of the national agricultural rural revenue (Embrechts et al., 1996). More recently (from 2008-2010), only 4 million tons were grown, likely in part due to BXW devastation (Kikulwe and Asindu, 2020). Per capita, the region has the highest consumption in the world and most of the crops are consumed locally (Kalyebara, Nkuba, Ramadhan, Byabachwezi, and Edmeades, 2007), including by more than seven million people (65% of the population) in urban areas (Karamura et al., 1998).

However, these economic measures in eastern regions of Africa do not occur in isolation but interrelate with social and environmental aspects as well. Banana was originally domesticated in southeast Asia, possibly as long ago as seven millennia in Papua New Guinea, with evidence for banana cultivation in Africa dating from the first millennium CE (Carney and Rosomoff, 2009). Importantly, because domestication of a plant species requires direct human intervention for the species’ successful reproduction and cultivation—in the case of banana, the deliberate removal and replanting of the plant’s suckers that develop from its corm (Carney and Rosomoff, 2009)—this repeated human activity also tends to coalesce gradually into a series of socio-environmental norms and behaviors (indigenous knowledge and practice), including specific crop timings, seasonally repeated activities or rituals, and a cultural superstructure for supporting these activities (Carney and Rosomoff, 2009). This also includes networks of mutual aid groups, markets for selling the crop, and local specializations and specialists who provide technological, physical, or magical expertise to enable successful crop growth (Carney and Rosomoff, 2009). These are elements in the social pillar of sustainability for banana in the region.

Supporting this sociocultural pillar for sustainable development is not only necessary but also typically results in beneficial outcomes (often measured economically). For instance, in eastern Africa, several biotic threats to banana (including weevils, nematodes, fungal, and viral diseases) have been managed using cultural methods that included mulching, spacing, using acidic plant mixes, and intercropping with other plants, e.g., coffee and cassava (Ouma, 2009).

While this had a net-reduced economic productivity from banana per se, the gains from these social and environmental interventions maintained sufficient levels of food and income security that would likely have been (and were already facing threats of) decreased sufficiency (Ouma, 2009). Moreover, the social interventions in these cases did not especially introduce or risk the introduction of chemical, mono-cultural, or industrial farming means that have been shown to have pronounced environmental impacts (Martínez-Alier et al., 2010; Schneider et al., 2010). This integrating of the economic, social, and environmental “bottom lines" for interventions affecting banana production exemplify a sustainable developmental approach (Afful et al., 2019).

However, the BXW epidemic has since triggered a shift to other crops (especially coffee), as well as attempts to introduce genetically modified BXW-resistant banana - specifically, the banana suckers needed for planting - to Ugandan farmers (Kikulwe and Asindu, 2020). Without intending any comment on the beneficial or harmful effects from these shifts, the authors would simply note that they introduce potential/new environmental and social impacts through changes within the agricultural sector. For example, since 2015 - when BXW was declared under control (Gotor et al., 2020) - drastic decline in public investment to mitigate BXW followed and led to further resurgences of the disease (Gotor et al., 2020). While it is doubtless premature to say that banana farmers have been “abandoned,” it is also clear that Ugandan agriculture in general is also attempting to heavily focus on alternatives. That banana is a major staple for in-country consumption (Kalyebara et al., 2007) makes any such redirection of agricultural attention to other crops socially precarious.

Challenges for BXW mitigation

For BXW specifically in eastern Africa, the social aspect plays a large role in mitigating or eliminating the disease. Since 2001, BXW reached epidemic proportions in Africa, with production and income losses estimated at USD$35 million and USD$100 million in 2005 and 2006 alone (Nannyonga et al., 2015) and consequent negative impacts on people’s social livelihood and community wellbeing. Previous regional efforts (in Uganda and Tanzania) to control the disease met with only limited success (Tushemereiwe et al., 2006), and resurgences of

the disease in previously controlled area have been reported (Gotor et al., 2020; Ongu, 2014). Factors involved in these suboptimal outcomes include, but are not limited to:

1) Shortages of resources at every level, including the infeasibility of farmers applying control measures due to high intervention costs (Gotor et al., 2020), shortages of extension personnel, shortages of funds for creating and disseminating educational materials in farmer-useable formats (non-print, and translated into local dialects), and shortages of trainers for that material.
2) A lack of access by farmers to best-practices approaches for mitigating or preventing the disease (including often conflicting sources of BXW mitigation information when shared farmer-to-farmer rather than through extension services, or in the absence of extension officers or other knowledgeable people to provide “real-time” diagnoses of BXW in the field) (Tushemereiwe et al., 2006).
3) Farmer costs (of time and money) associated with BXW mitigation mandate compliance (McCampbell et al., 2018), which could often be offset by traditionally social intra-network materials and tool sharing farmer habits in Uganda that potentially increased the risk of BXW spreading (Bagamba et al., 2006; Blomme et al., 2014; Magala et al., 2019; Staver et al., 2010; Tinzaara et al., 2011).

In addition to the above, one study found that BXW mitigation compliance yielded a net $35 per acre per annum benefit for full adopters, a $30 benefit for partial adopters, and a net $30 per acre per annum loss for non-adopters (Gotor et al., 2020). Given the relatively modest per acre gain for full adoption compared to partial adoption, Gotor et al. (2020) reasonably propose that onerous front-end costs explain why only 33% of farmers fully adopted the mitigation measures, and 62% only partially adopted them. Using an average Ugandan banana farm size of 0.8 ha (Jogo et al., 2011), this yields an approximately net $10 per year for full adoption over partial adoption. Larger farms would reap larger grains; smaller farms smaller.

From 2013-2016, when BXW was most comprehensively funded for intervention in Uganda, the most effective approach involved demonstrations to farmers about (1) exclusively using only clean planting materials and (2) monitoring strategies to identify BXW, which ultimately reduced the percentage of affected farms from 50% in 2013 to 1.9% in 2015 (Gotor et al., 2020). These technique-interventions were perceived by solution providers as highly effective (Gotor et al., 2020). Since that success, however, “control of the BXW was entirely entrusted to rural households” (Gotor et al., 2020) and has resulted in resurgences of BXW.

Because BXW is highly infectious and spreads rapidly (Jogo et al., 2011), five principal control measures were proposed to mitigate its propagation:

1) Advising farmers to conduct pruning after three months once they identify plants that are infected
2) Cutting infected suckers before infesting the top fruiting parts
3) Uprooting and destroying any sucker identified as wilting (yellowish appearance)
4) Removing the male bud once the banana has fruited and formed fingers (using a forked stick), and
5) Exclusively using only disinfected tools, particularly with emphasis on pangas [a specialized cutting knife] (Jogo et al., 2011).

These efforts aim to reduce the major identified vectors of disease transmission (namely: insects, plant material exchange, and infected tools). However, the role for each of these factors or their specific combination in disease spread is still not well-characterized (Kilwinger et al., 2019; ProMusa, 2021; Tinzaara et al., 2011). For example, although BXW is transmissible by insects, it is less susceptible to this compared to other banana diseases (ProMusa, 2021). Similarly, while sharing plant materials among farmers readily transmits BXW, limited plant material sharing has been observed among farmers, which likely diminishes the role of that vector at present (Kilwinger et al., 2019). Lastly, infected tools have been shown play a larger role in the area considered in this study (Mbarara district) than insect transmission (Jogo, Karamura, Tinzaara, Kubiriba, and Rietveld, 2013). Whatever the exact roles of these established vectors, an only 62% partial adoption of BXW mitigation measures will play key role in any resurgence of the disease (Gotor et al., 2020).

Kikulwe et al. (2018) underscores how the five BXW mandates above must be specifically and necessarily cultural; “The only disease management strategy for crop protection against BXW in Uganda is the use of one or a combination of cultural BXW control practices” (88), which when implemented correctly can result (and have resulted) in complete control of the disease (Karamura et al., 2008). Among the five recommendations, number 5 (“exclusively using only disinfected tools, particularly with emphasis on pangas”) adds overhead to farmer budgets by requiring them to purchase, or otherwise freely acquire, disinfectant for their tools and up to three different pangas for cutting banana leaves when cooking (because using one knife increases the risk of contaminating other plants). Without support for these additional costs, BXW mitigation efforts can suffer due to decreased solution-uptake or compliance (Gotor et al., 2020; Kikulwe et al., 2018).

In one study, Kikulwe et al. (2019) provided Ugandan banana farmers with the resources needed for the adoption and practice of three cultural BXW control measures. While the majority of participants (80%+) assented to the effectiveness of these measures,

subsequent non-adoption of the BXW control measures among participants associated with farm size, i.e., smaller, non-commercial farms were less able to afford the resources required for the tested control measures. Kikulwe et al. (2019) also specifically observed that "women-inclusive training and farmer-preferred information dissemination pathways" (13) would enhance adoption; Gotor et al. (2020) echoed this point.

In particular, this emphasis on women and female-owned farm households not only raises the important social issue of gender with respect to sustainably securing full BXW mitigation compliance (Kikulwe et al., 2018) but also bears directly on the fifth recommendation above, since its requirement to use three pangas for cooking applies explicitly (if not exclusively) to women (and female-headed farms). Beyond differential perceptions of BXW control by men and women (Kikulwe et al., 2018), delivering BXW control messaging to Ugandan women will face the usual constraints found in a majority of rural situations, i.e., decreased access to education, literacy, extension services, and agricultural resources generally (Bello-Bravo and Lutomia, 2016; Bello-Bravo et al., 2017, 2019). As Kikulwe et al. (2018) stresses, "It is therefore critical that existing gender-based and underlying perception constraints are addressed" (87).

Messaging

How BXW mitigation messaging is delivered matters as much as what is delivered (Bello-Bravo, 2020a; McLuhan, 2009), whether in women-inclusive ways, through farmer-preferred dissemination channels, or other means. This specifically cultural element of delivery has redoubled significance when addressing BXW mitigation regionally (across Uganda and Tanzania specifically, but including Rwanda, Burundi, and eastern Democratic Republic of Congo as well).

As a trans-boundary problem (Ansell et al., 2010), it risks cultural incompetence and irrelevance to address BXW control problems regionally using only one cultural form of the message. The most obvious point where this risk occurs involves the requirement to translate any messaging materials into locally most comfortably spoken dialects (Rodríguez-Domenech et al., 2019), but this translation is as much culturally behavioral as linguistic (Braçaj, 2015; Kikulwe et al., 2018).

Although effective communication and message delivery always becomes more challenging during a crisis (Reynolds and Seeger, 2005), self-organization responses can often complement or stand in place of more top-down responses (Kendra and Wachtendorf, 2001; Miresmailli et al., 2015; Solnit, 2010). One advantage of such self-organized responses includes their often culturally competent and relevant character. Nonetheless, as Kikulwe et al. (2019) makes clear in the differential adoption rates by farm size, even within a culture certain variations can exist that generate obstacles to BXW mitigation messaging. In a trans-boundary context like BXW - holding all other "logistical" needs for coordination equal - attention to cultures (in the plural) becomes paramount for more effectively ensuring that BXW mitigation messaging gets received in all contexts delivered. This is not only because "one size fits all" (or even regional-level) BXW mitigation will likely not be effective in all cultural contexts, but also because differences in national-level commitment or mitigation approaches can vary in a way that makes one nation susceptible to less effective mitigation by their neighbors. Locally in Uganda, as the extension agent interviewed for this study noted: "The current way of delivering [BXW mitigation] messages to local farmers is efficient because of the language, message, visuals, and extension materials, but one of the challenge is to reach all the farmers." Achieving fuller compliance involves precisely reaching more farmers, especially female farmers.

METHODOLOGY

Study area

In Uganda, Mbarara district is the country's second largest banana growing region and one of the hardest hit for banana production due to BXW and declining soil fertility (Namara, 2018). For that reason, it was selected for this study.

Participants

Participants from both small-scale and large-scale/commercial banana farms in Kashaka parish (in Bubaare subcounty, Mbarara) were recruited on the criteria of farm accessibility, willingness of farmers to take part in the study, and the prevalence and past mitigation efforts against BXW in the area. Previously, Kashaka parish had had the highest number of BXW-affected farmers (during the highest-impact period of BXW from 2013-2016) but in the last five years have registered fewer cases of the disease at the District Agricultural Office. In all, 17 participants (detailed in the findings below) were identified and formally consented to participate in the study.

Data collection

During February, 2019, researchers collected data from group and open-ended, in-depth personal interviews with participants, a technology usage questionnaire, and feedback on a video animation format for delivering information and communication technology (ICT) educational content on BXW mitigation. Researchers also conducted farm walk-throughs of banana plantations to collect observational data on farm acreage, plant appearance, application of control measures, modifications to the five (government-recommended) control mechanisms suggested for the control of BXW (Jogo et al., 2011), and inter-cropping strategies.

Group and individual interviews explored topics around farmer experiences with BXW, methods used to control the disease, where they had learned of those methods, any modifications to the methods they applied, if any, as well as success stories and identification of further support information participants desired about the symptoms, transfer, and mitigation methods to control, prevent, or eliminate the disease. As part of the group interviews,

qualitative feedback from participants was elicited after presenting an educational animation on BXW mitigation (translated into the participants' most comfortably spoken local dialect). All group and individual interview data were recorded, transcribed, and member-checked with participants to enhance validity (Birt et al., 2016), coded independently by two researchers using a framework of social wellbeing around themes and subthemes related to farmer experiences with BXW (Saldaña, 2016), and then conferenced by both researchers to resolve any coding discrepancies and achieve full inter-rater agreement (Gwet, 2014).

Participants also answered a questionnaire about ownership of technology channels (e.g., radio, TV, mobile phones, and Internet), how they received communications about BXW (e.g., from media, including newspaper, agricultural regulation authorities, other farmers, along with the kinds of information shared, frequency of sharing, sharing-media, and the feasibility of sharing information using different media when relevant to BXW), and socioeconomic impacts of BXW control methods.

Data analysis

Interview data were coded by two researchers and conferenced to resolve any discrepancies until an inter-rater agreement of 100% was achieved (Gwet, 2014). Codes were then clumped into themes and both member-checked and triangulated against documentary data (Mathison, 1988; Olsen, 2004). For questionnaires, dichotomous answers were tallied and more open-ended question items were coded as above to triangulate group and individual interview data (Mathison, 1988; Olsen, 2004).

FINDINGS AND DISCUSSION

In total, the 17 participants included 1 extension agent (in-depth interviewed), and 16 farmers (12 group-interviewed and 4 open-endedly interviewed personally in-depth). Demographically, 10 farmer-participants (63%) were male and 6 (37%) were female. Educationally, 4 (25%) had no formal education, while 4 (25%) had a primary-level (Grade 1 to 7) and 8 (50%) had a secondary-level (Grade 8 to 13) formal education. Thematic analysis of all collected data yielded two main themes related to social wellbeing (as part of the social pillar of sustainability): namely (1) social contexts generally (including farm coverage, habits, and trans-boundary issues) and (2) key issues affecting full compliance with BXW mitigation measures (including challenges related to disinfecting tools and the limited reach of BXW mitigation messaging). There are addressed in turn below.

Socio-demographic contexts

Farm coverage and practices

Out of four farms visited, few cases of BXW were observed, with an infection rate of approximately 1% of the total banana plantation crops in the study. Despite this low prevalence, all participants expressed concern about the disease, in part for having been made acutely aware of the problem during the 2013-2016 height of BXW (Gotor et al., 2020). The most-reported methods of control included the use of JIK (a disinfectant), iodized salt, rock salt (locally referred to as kisula), and wood ash to sanitize farm equipment during and after use. Wood ash is also poured onto infected cut banana stumps and stems to control transmission from one plant to another. The majority of participants suggested that more mitigation training, as well as lowering the cost of disinfectants like JIK, was needed, echoing other research (Gotor et al., 2020; Kikulwe et al., 2018; Kilwinger et al., 2019). Although 90% reported using JIK as an effective disinfectant for farm equipment during and after pruning banana plants, they also highlighted the issue of counterfeit JIK, suggesting that authorities should better ensure a more reliable supply of authentic products.

Trans-boundary themes

BXW is a trans-boundary problem that readily crosses international nation-state boundaries (McCampbell et al., 2018). While this requires regional coordination, solutions must still be made locally and culturally practical and feasible (Schmidt, Stiefel, and Hürlimann, 1997). In the present study, only the extension agent explicitly addressed the trans-boundary aspect of BXW.

This is a cross-border disease. Communication with Uganda (from other regional actors) in terms of research and findings is taking place, and implementation of any solution strives to be sustainable. Different stakeholders are involved in the research so that it becomes sustainable. The extension agriculture office is involved at the district level and at the regional level. They can share some data, but this problem has affected the livelihoods of communities in the affected areas. Coordination is difficult. There are seven districts and eight local governments. And data from Tanzania (Mapinda et al., 2019) is suggesting that contaminated soil may be more important for transmission than thought previously.

Importantly, Mapinda et al. (2019) also emphasize infected tools as an important transmission vector in Tanzania. Because JIK is not effective when tools are dipped for less than three minutes (Mwangi et al., 2007), this impacts the fifth recommendation above - namely, to exclusively use only disinfected tools and at least three pangas for cooking. Dipping and waiting for more than three minutes per use for a single tool to disinfect when cooking and working in the field is prohibitively time-intensive. Fire also can disinfect field and cooking tools (Shimwela et al., 2016), but is also typically too time intensive to ensure effective sterilization or compliance (Jogo et al., 2013).

Key problems

Given labor-availability differences (e.g., farm or family

size) (Jogo et al., 2013) and drastic reductions in national-level support such that "control of the BXW [has been] entirely entrusted to rural households" (Gotor et al., 2020), a do-it-yourself (DIY) ethos may be needed to achieve the necessary diffusion of "cultural BXW control practices" (Kikulwe et al., 2018:88), especially among less labor-equipped or poorer farms. Full BXW control means persuading partial adopters to become full adopters. Accordingly, two main themes emerged as constraints on full BXW mitigation compliance: (1) issues around disinfection of tools, including cost, counterfeit JIK, and the cultural infeasibility of requiring the purchase of additional tools to ensure sterilization, and (2) insufficient reach of BXW mitigation information to all potential message recipients, particularly women.

Disinfecting tools

Participants noted that full adoption of recommended BXW mitigation measures adds considerable physically taxing work to farmers' everyday lives, all the more so on family or small farms with limited labor, echoing previous research (Jogo et al., 2013). As such, farmer decision-making about compliance will involve perceptions about the value of BXW mitigation practices (Bagamba et al., 2006) and weighing any additional time-consuming and physically exhausting compliance.

Social wellbeing, as a major component of the social pillar of sustainability, involves a person's "relationship with other people, the neighborhood, and the community" (Keyes and Shapiro, 2004:350) and their "social integration, social contribution, social coherence, social actualization, and social acceptance" (Keyes, 1998:121). Not being able to realize these goals due to exhaustion or a lack of time ruinously impacts social sustainability. Requiring mitigation compliance without supporting these social goals risks decreased BXW control, physical and mental health, and decreased productivity (Bentein et al., 2017; Ferreira et al., 2019; Kloutsiniotis and Mihail, 2020; Molia et al., 2015). As such, in addition to the economic (financial) impacts involved tool disinfection compliance (Kilwinger et al., 2019; Langyintuo and Mekuria, 2008), the prohibitive and additional social costs involved in the time-intensiveness of disinfecting tools, whether by JIK or fire, affect compliance and BXW control as well (Jogo et al., 2013; Mapinda et al., 2019; Mwangi et al., 2007).

The most ideal outcome would be for farmers to adopt all BXW mitigation recommendations (Bagamba et al., 2006; Gotor et al., 2020; Jogo et al., 2013; Kikulwe et al., 2019). In fact, tool disinfection mandates are not the most noncompliant item. At the beginning of the most recent BXW crisis in 2013, Jogo et al. (2013) measured the percentage of tool disinfection compliance as third and second-best (of six items) for East African highland banana (68.6%) and Kayinja 'beer' banana (58.4%) production systems and high-altitude (78.2%) and medium-to-low-altitude (59.2%) farms, respectively, and third-best overall (63.5%). By 2019, however, approximately 11% of farmers perceived tool disinfection not effective (Kikulwe et al., 2019). More research would be needed to determine why Ugandan farmers complying with this mitigation item compared to others is not (or no longer) a good use of their time within the daily calculus and allocation of their farm activities.

Limited reach of BXW mitigation messaging

With a highly infectious disease like BXW, ensuring disease-mitigation knowledge delivery to the widest possible number of message recipients is needed (Bello-Bravo, 2020a; Biruma et al., 2007). Participants reported receiving BXW mitigation messaging through traditional channels (e.g., government/extension workers, other farmers, and media, including radio and televisions) and digital ICT channels. The extension agent observed that:

Farmers have mobile phones and can receive SMS messages and also have access to radio, posters, calendar, cartoon books to convey information. There are radio talks twice a week; farmers call and ask questions and the feedback is very positive. Also, some radio programs offer agricultural educational programs for farmers. Almost every farmer has a radio. TV depends on the locality but TV is more effective. Farmers ask questions on agronomic practices. [Our institution] organizes outreach through face to face, visiting farmers and asking them questions. Sometimes they organize training; this is done in Swahili.

While all participants reported having radios and the ability to access local radio stations, only 60% reported having TVs. Despite these available communication channels, participants did not report currently receiving any BXW messaging. Several noted that BXW mitigation programs had been previously available on these channels but were funded by projects that had since gone off the air.

Although all farmers reported access to at least one information and communication technology (ICT) channel -including radio, television, mobile phones, and the Internet—rural Internet access could vary widely, particularly given poor wireless infrastructures. This echoes similar findings on challenges facing rural Internet and mobile phone usage in Uganda (Boulahya et al., 2005; Eilu, 2018). For example while all participants reported having mobile phones, only 40% had video-enabled smart phones, with the remainder having medium- to low-technology phones usable only for receiving and sending texts and calls. Several also acknowledged not using the text feature on their phones, while the majority reported a preference for video messages and audio. More specifically, while 100% of participants reported using mobile phones as a flashlight and for personal and business calls, only 80% used them

for texting, and only 10% used them as a learning tool (e.g., to access information about BXW mitigation).

Mobile phones are being underutilized for educational purposes. Often, the costs of mobile phones, data plans, or limited coverage affect this and can necessitate phone sharing (Chiumbu, 2012; Wesolowski et al., 2012). For example, all participants reported having access to neighbors' phones (including for sending and receiving money and watching videos). In terms of usage, 75% reported keeping their phones on at all times, while 25% reported not being able to do so due to a lack of, or no access, to electricity for recharging or interruptions of (upstream) network connections. Moreover, with respect to receiving messages, 100% of participants reported text-capabilities on their phones, but 20% reported difficulties or barriers to receiving them, including technological limitations or malfunctions and non-print literacy in the dialect used for the text. Among the 80% of participants who reported understanding text messages, 50% stated that text messages in the local dialect were easier to understand; the other 50% reported being comfortable with text messages in English and Luganda

BXW mitigation animation

With respect to feedback on the BXW mitigation educational animation shown to participants, 100% of participants with smartphones expressed a willingness to follow such agricultural problem-solving videos if sent to their phones.

Participants were also very enthusiastic about the practice of the method illustrated in the video, which echoes the 80%+ positive perception of existing BXW mitigation recommendations (Kikulwe et al., 2019). However, many participants added that the steps or required materials for the method would have to be within their means (accessible and affordable); perhaps relatedly, the recommendation to disinfect tools also had the highest "not effective" perception (~11%) by farmers in Kikulwe et al. (2019). This perception of ineffectiveness almost certainly makes any time-calculation about the value of BXW mitigation compliance less convincing.

Study participants agreed that it was easier for them to follow and utilize a video or a message with a local dialect voiceover. Relatedly, Kikulwe et al. (2019) found that farmers perceived non-print forms of communication, including radio shows, farmer-to-farmer interactions, and extension visits, as more effective than print forms, which likely relates to print literacy and educational levels generally. However, audio (non-print) delivery includes the social aspect of spoken-word communications (whether in person, by radio, or through the use of voiceovers in the video animations); for example, Tata and McNamara (2016) found that female learners in Kenya preferred face-to-face rather than computer-mediated learning. Similarly, animated educational videos can elicit participant interest simply through hearing their mother-tongue in (animated) recorded media for the first time in their lives (Bello-Bravo et al., 2019; Bello-Bravo et al., 2011; Rodríguez-Domenech et al., 2019).

Besides the personal appeal of the animation presented in this study, participants also reported a willingness to share the video, when means permitted, with others (e.g., neighbors, friends, and relatives), either electronically or by phone-sharing. Electronic means can include Bluetooth, if the person is close by, apps like WhatsApp if access to the Internet is available, or simply by replaying the video on an owned or borrowed phone (Bello-Bravo and Pittendrigh, 2018). An additional 20% reported being able to use a flash drive to share files by transferring them. This form of sharing not only ensures the (recorded) message's informational integrity when the video is replayed (Bello-Bravo and Pittendrigh, 2018) but also affords reaching community members, especially women, not otherwise likely to be reached (Bello-Bravo et al., 2020).

Gender

Although reaching female farmers is recognized as a critical need in Ugandan banana farming (Gotor et al., 2020; Kikulwe et al., 2018), in part because women more often implement actual BXW mitigation measures (even on male-owned farms) and "are more engaged in day-to-day management of banana plantations" than men (Kikulwe et al., 2019, p. 11), social and educational barriers alike generally constrain their access to BXW mitigation-type messaging and can decrease adoption (Kikulwe et al., 2018). That linguistically localized animations have demonstrated statistically significant knowledge transfer without regard to gender, education, or socioeconomic level (Bello-Bravo et al., 2018) makes them well-suited for bypassing these social constraints, while also enabling women's neighbors, friends, and relatives to informally share the video on mobile phones where they work or live (Bello-Bravo et al., 2019).

Conclusion

Green economy efforts rest on and rely upon incorporating economically, socially, and environmentally sustainable practices. While acknowledging the tendency to predominate or prioritize economic costs and benefits within sustainability efforts, this paper also highlighted the social impacts of time-costs on Ugandan farmers' social lives and their social wellbeing as a factor for BXW mitigation partial compliance. Future research might apply themes and insights from the literature on burnout, emotional exhaustion and work productivity, and their impacts on social wellbeing for Ugandan banana farmers (if not African farmers generally) to better support the social pillar of sustainability. Currently, it seems little to no such research has been done on this issue.

Moreover, as investments in female farmers' knowledge typically have greater returns than similar investments with men, a participatory design process to (1) identify a cost- and time-effective local tool disinfection technique, (2) proof-concept it, and then (3) present its steps in a clear, simple, and locally translated animated educational protocol sharable on video-enabled phones in Uganda will not only potentially increase BXW mitigation perceptions and compliance for this item but also afford an opening for reaching underserved and overlooked members of the Ugandan banana production value-chain generally. Such enhanced BXW mitigation compliance and better food security overall for Uganda secure broader trans-boundary benefits regionally.

RECOMMENDATIONS

While the above clearly lays out an argument for recommending the use of animated educational videos to readily extend the reach of current BXW mitigation measures and potentially increase mitigation compliance, other barriers intrude. For example, only 40% of participants reported having video-enabled smartphones, while 80% reported that the majority of the people they would want to send such an animation to would likely not have smartphones and thus could not receive or retrieve such videos. This is a problem of cost, not technological literacy; among the 60% of participants without smartphones (and thus unable to receive or send videos); the cost of smartphones was cited as a barrier, with only 20% reporting a lack of education or skills as a barrier. Of those able to receive and send videos with smart phones, only 25% reported being able to access that service all day and all the time; the remaining 75% cited the high price of internet services or inadequate access to air time as a barrier - mobile internet costs approximately 2.00-3.99% of monthly income (DW, 2021). Participants also agreed that having to walk long distances (or pay transport fees) to buy air time or access airtime loading kiosks limited any ability to receive or send videos. Accordingly, participants proposed the use of printed airtime vouchers over electronic systems, since one could then buy several vouchers at once and keep re-loading data plans at their convenience.

Even assuming a financial feasibility to providing no-cost video-enabled smartphones with free data plans for viewing and sharing BXW mitigation videos that emphasize tool disinfection, this would still not address the social time-cost of the requirement. Rather, we recommend - echoing Jogo et al. (2013) - a collaborative process with Ugandan smallholder banana farmers and global and local BXW mitigation experts to:

1) Identify a readily available, low- to no-cost, and socially sustainable tool disinfectant solution-method,
2) Perform a proof of concept of easily replicated and learned steps for applying that method, and then
3) Produce an educational animation translated into local dialects that demonstrate those method-steps for farmer training and dissemination through the existing smartphone resources in Uganda.

Notably, a similar approach by Mocumbe (2016) measured a 97.9% knowledge retention and 89% solution-adoption at a two-year follow-up post-training for an improved postharvest seed-storing approach using jerrycans (Bello-Bravo et al., 2020).

Self-evidently, the constraints imposed by limited smartphone ownership among Ugandan banana farmers mandate creative local solutions for enabling the full realization of the participatory process above. However, whatever protocol is determined for a specific, actionable, and socially sustainable method for disinfecting tools, such protocol content and any steps for full compliance with BXW mitigation measures could be included in the educational animation, thus extending the reach of BXW messaging to demographics currently missed or overlooked, especially women. Moreover, the DIY context that now places responsibility for BXW mitigation predominantly on farmers and farms means that grassroots efforts and volunteerism may be the only (or best) resource for realizing a socially sustainable, time-effective solution for securing tool disinfection compliance. By no means the most ideal route - given that better funded, or actually funded, efforts would more readily enable the participatory project above - if this is currently the only visible pathway, then one must take it (pending still-better options) given that securing some additional compliance for BXW mitigation is more desirable than achieving none or leaving it to chance. Through such an approach, the social wellbeing of farmers - in terms of more access to daily life by having more time away from work during the day - affords critical support for social sustainability in general.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Afful A, Kumi-Acquah GK, Agyekum K (2019). Level of knowledge of design professionals on the principles of social sustainability in Ghana. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3511538

Ansell C, Boin A, Keller A (2010). Managing transboundary crises: Identifying the building blocks of an effective response system.

Journal of Contingencies and Crisis Management 18(4):195-207. doi:10.1111/j.1468-5973.2010.00620.x
Bagamba F, Kikulwe E, Tushemereirwe W, Ngambeki D, Muhangi J, Kagezi G, Green S (2006). Awareness of banana bacterial wilt control in Uganda: 1. Farmers' perspective. African Crop Science Journal 14(2):157-164.
Bello-Bravo J (2020a). Getting the message across: Characterizing a need to bridge public health messaging for tuberculosis across a rural/urban and CHW/traditional healer divide in Madagascar (A Review). Scientific Africa: e00321. doi:10.1016/j.sciaf.2020.e00321.
Bello-Bravo J (2020b). Managing biodiversity & divinities: Case study of one twenty-year humanitarian forest restoration project in Benin. World Development 126:104707. doi:10.1016/j.worlddev.2019.104707.
Bello-Bravo J, Abbott E, Mocumbe S, Mazur R, Maria R, Pittendrigh BR (2020). An 89% solution adoption rate at a two-year follow-up: Evaluating the effectiveness of an animated agricultural video approach. Information Technology for Development 26(3):577-590. doi:10.1080/02681102.2019.1697632
Bello-Bravo J, Lutomia AN (2016). Making agricultural learning inclusive: The case of mobile learning and women in Mozambique. Presented at the Twelfth International Congress of Qualitative Inquiry, Urbana, IL, 18-21 May 2016.
Bello-Bravo J, Lutomia AN, Abbott E, Mazur R, Mocumbe S, Pittendrigh BR (2020). Making agricultural learning accessible: Examining gender in the use of animations via mobile phones. In M Khosrow-Pour, S Clarke, ME Jennex and A-V Anttiroiko (Eds.), Environmental and agricultural informatics: Concepts, methodologies, tools, and applications (pp. 716-736). Hersey, PA: IGI.
Bello-Bravo J, Lutomia AN, Njoroge TM, Pittendrigh BR (2019). Beyond binaries of scientific and indigenous knowledge bean storage techniques: A case of market women in Ghana. In S Hameed, S el-Kafafi and R Waretini-Karena (Eds.), Handbook of research on indigenous knowledge and bi-culturalism in a global context (pp. 38-60). Hershey, PA: IGI.
Bello-Bravo J, Lutomia AN, Pittendrigh BR (2017). Information literacy to prevent bean losses using animated videos: A pilot study of women entrepreneurs in Cape Coast, Ghana. Global Journal of Environmental Science and Technology, 5(3):445-459.
Bello-Bravo J, Lutomia AN, Pittendrigh BR (2019). Changing formal and informal learning practices using smartphones: The case of market women of Ghana. In DP Peltz and AC Clemons (Eds.), Multicultural andragogy for transformative learning (2nd ed., pp. 171-193). Hershey, PA: IGI Global.
Bello-Bravo J, Pittendrigh BR (2018). Scientific Animations Without Borders (SAWBO): Animating IPM information and education everywhere. Outlooks on Pest Management, 29(2):58-61. doi:10.1564/v29_apr_02
Bello-Bravo J, Seufferheld F, Adebimpe A (2011). Gender and farmer field schools in food and agricultural production systems in select crops and regions of West Africa. The International Journal of Science in Society 2(4):13-24. doi:10.18848/1836-6236/CGP/v02i04
Bello-Bravo J, Tamò M, Dannon EA, Pittendrigh BR (2018). An assessment of learning gains from educational animated videos versus traditional extension presentations among farmers in Benin. Information Technology for Development, 24(2):224-244. doi:10.1080/02681102.2017.1298077
Bentein K, Garcia A, Guerrero S, Herrbach O (2017). How does social isolation in a context of dirty work increase emotional exhaustion and inhibit work engagement? A process model. Personnel Review 46(8):1620-1634. doi:10.1108/PR-09-2016-0227
Birt L, Scott S, Cavers D, Campbell C, Walter F (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? Qualitative Health Research 26(13):1802-1811. doi:10.1177/1049732316654870
Biruma M, Pillay M, Tripathi L, Blomme G, Abele S, Mwangi M, Bandyopadhyay R, Muchunguzi P, Kassim S, Nyine M. (2007). Banana Xanthomonas wilt: A review of the disease, management strategies and future research directions. African Journal of Biotechnology 6(8):953-962.
Blomme G, Jacobsen K, Ocimati W, Beed F, Ntamwira J, Sivirihauma C, Ssekiwoko F, Nakato V, Kubiriba J, Tripathi L (2014). Fine-tuning banana Xanthomonas wilt control options over the past decade in East and Central Africa. European Journal of Plant Pathology 139(2):271-287. doi:10.1007/s10658-014-0402-0
Boulahya M, Cerda MS, Pratt M, Sponberg K (2005). Climate, communications, and innovative technologies: potential impacts and sustainability of new radio and internet linkages in rural African communities. In J Salinger, M Sivakumar and RP Motha (Eds.), Increasing climate variability and change (pp. 299-310). Dordrecht, Netherlands: Springer.
Braçaj M (2015). Procedures of translating culture-specific concepts. Mediterranean Journal of Social Sciences 6(1 S1): 476-480. doi:10.5901/mjss.2015.v6n1s1p476
Carney J, Rosomoff RN (2009). In the shadow of slavery: Africa's botanical legacy in the Atlantic world. Berkeley, CA: University of California Press.
Chiumbu S (2012). Exploring mobile phone practices in social movements in South Africa–the Western Cape Anti-Eviction Campaign. African Identities 10(2):193-206. doi:10.1080/14725843.2012.657863
Corntassel J (2008). Toward sustainable self-determination: Rethinking the contemporary Indigenous-rights discourse. Alternatives 33(1):105-132. doi:10.1177/030437540803300106
Desai K (2017). Girlscape: Transnational productions of neoliberal girlhoods. (PhD), Teachers College, New York City, NY.
Ehl D, Grün GG (2021). Why mobile internet is so expensive in some African nations. Retrieved 16 March, 2021, from https://www.dw.com/en/why-mobile-internet-is-so-expensive-in-some-african-nations/a-55483976#:~:text=On%20average%2C%20African%20providers%20charge,American%20continent%20has%20higher%20prices.
Eilu E (2018). An assessment of mobile internet usage in a rural setting of a developing country. International Journal of Mobile Computing and Multimedia Communications 9(2):47-59. doi:10.4018/IJMCMC.2018040104
Embrechts J, Bananuka JA, Couveur Y, Bagamba F (1996). Banana sub-sector review, Republic of Uganda. (STABEX), Service Contract No. SCl26196. Kampala, Uganda: Republic of Uganda.
Errington F, Gewertz D (1989). Cultural alternatives and a feminist anthropology: An analysis of culturally constructed gender interests in Papua New Guinea. New York City, NY: Cambridge University Press.
Ferreira AI, da Costa Ferreira P, Cooper CL, Oliveira D (2019). How daily negative affect and emotional exhaustion correlates with work engagement and presenteeism-constrained productivity. International Journal of Stress Management 26(3):261-271. doi:10.1037/str0000114
Goodman R, Tripathi L, Tripathi J (2021). Controlling banana xanthomonas wilt disease in east Africa. Retrieved 10 September, 2021, from https://www.openaccessgovernment.org/controlling-banana-xanthomonas-wilt-disease-in-east-africa/117771/
Gotor E, Di Cori V, Pagnani T, Kikulwe E, Kozicka M, Caracciolo F (2020). Public and private investments for banana Xanthomonas Wilt control in Uganda: The economic feasibility for smallholder farmers. African Journal of Science, Technology, Innovation and Development 14(1):135-146. doi:10.1080/20421338.2020.1816616.
Gwet KL (2014). Handbook of inter-rater reliability: The definitive guide to measuring the extent of agreement among raters (4th ed.). Gaithersburg, MD: Advanced Analytics, LLC.
Jogo W, Karamura E, Kubiriba J, Tinzaara W, Rietveld A, Onyango M, Odongo M (2011). Farmers' awareness and application of banana Xanthomonas wilt control options: the case of Uganda and Kenya. Journal of Development and Agricultural Economics 3(11):561-571.
Jogo W, Karamura E, Tinzaara W, Kubiriba J, Rietveld A (2013). Determinants of farm-level adoption of cultural practices for Banana Xanthomonas wilt control in Uganda. Journal of Agricultural Science 5(7):70-81. doi:10.5539/jas.v5n7p70
Kalyebara R, Nkuba JM, Ramadhan MS, Byabachwezi EMK, Edmeades S (2007). Overview of the banana economy in the Lake Victoria regions of Uganda and Tanzania. In M Smale and WK Tushemereirwe (Eds.), An economic assessment of banana genetic improvement and innovation in the Lake Victoria region of Uganda and Tanzania (pp. 25-36). Washington, DC: International Food Policy Research Institute.

Karamura E, Frison E, Karamura D, Sharrock S (1998). Banana production systems in eastern and southern Africa. In C Picq, E Foure and E Frison (Eds.), Bananas and food security. (pp. 401-412). Montpellier, FR: International Network for the Improvement of Banana and Plantain (INIBAP).

Karamura E, Turyagyenda F, Tinzara W, Blomme G, Ssekiwoko F, Eden-Green S, Molina A, Markham R (2008). Xanthomonas wilt of bananas in East and Central Africa. Diagnostic and Management Guide. Kampala, Uganda: Bioversity International, Uganda. INIBAP ISBN 978-982.

Kendra J, Wachtendorf T (2001). Elements of community resilience in the World Trade Center attack. Disasters 27(1):37-53.

Keyes CLM (1998). Social well-being. Social Psychology Quarterly 61(2):121-140.

Keyes CLM, Shapiro AD (2004). Social well-being in the United States: A descriptive epidemiology. In OG Brim, CD Ryff and RC Kessler (Eds.), How healthy are we? A nantional study of well-being at midlife (pp. 350-372). Chicago, IL: Univiersity of Chicago Press.

Kikulwe EM, Asindu M (2020). A contingent valuation analysis for assessing the market for genetically modified planting materials among banana producing households in Uganda. GM Crops & Food 11(2):113-124. doi:10.1080/21645698.2020.1720498

Kikulwe EM, Kyanjo JL, Kato E, Ssali RT, Erima R, Mpiira S, Ocimati W, Tinzaara W, Kubiriba J, Gotor E (2019). Management of Banana Xanthomonas Wilt: Evidence from impact of adoption of cultural control practices in Uganda. Sustainability 11(9):2610. doi:10.3390/su11092610

Kikulwe EM, Okurut S, Ajambo S, Gotor E, Ssali RT, Kubiriba J, Karamura E (2018). Does gender matter in effective management of plant disease epidemics? Insights from a survey among rural banana farming households in Uganda. Journal of Development and Agricultural Economics 10(3):87-98. doi:10.5897/JDAE2017.0877

Kilwinger F, Rietveld A, Groot JC, Almekinders CJ (2019). Culturally embedded practices of managing banana diversity and planting material in central Uganda. Journal of Crop Improvement 33(4):456-477. doi:10.1080/15427528.2019.1610822

Kloutsiniotis PV, Mihail DM (2020). Is it worth it? Linking perceived high-performance work systems and emotional exhaustion: the mediating role of job demands and job resources. European Management Journal 38(4):565-579. doi:10.1016/j.emj.2019.12.012

Langyintuo AS, Mekuria M (2008). Assessing the influence of neighborhood effects on the adoption of improved agricultural technologies in developing agriculture. African Journal of Agricultural and Resource Economics 2(311-2016-5528):151-169. doi:10.22004/ag.econ.56960

Luetz JM, Walid M (2019). Social responsibility versus sustainable development in United Nations policy documents: A meta-analytical review of key terms in human development reports. In WL Filho (Ed.), Social Responsibility and Sustainability (pp. 301-334). Cham, CH: Springer.

Magala DB, Najjingo Mangheni M, Miiro RF (2019). Actor social networks as knowledge sharing mechanisms in multi-stakeholder processes: a case of coffee innovation platforms of Uganda. The Journal of Agricultural Education and Extension 25(4):323-336. doi:10.1080/1389224X.2019.1629971

Mapinda JJ, Mwanga GG, Masanja VG (2019). Modelling the transmission dynamics of banana xanthomonas wilt disease with control measures. Journal of Mathematics and Informatics 17:113-129. doi:10.22457/jmi.151av17a11

Martínez-Alier J, Pascual U, Vivien F-D, Zaccai E (2010). Sustainable de-growth: Mapping the context, criticisms and future prospects of an emergent paradigm. Ecological Economics 69(9):1741-1747. doi:10.1016/j.ecolecon.2010.04.017

Mather AS, Fairbairn J, Needle CL (1999). The course and drivers of the forest transition: The case of France. Journal of Rural Studies 15(1):65-90. doi:10.1016/S0743-0167(98)00023-0

Mathison S (1988). Why triangulate? Educational researcher 17(2):13-17. doi: http://www.jstor.org/stable/1174583

McCampbell M, Schut M, Van den Bergh I, van Schagen B, Vanlauwe B, Blomme G, Gaidashova S, Njukwe E, Leeuwis C (2018). Xanthomonas Wilt of Banana (BXW) in Central Africa: Opportunities, challenges, and pathways for citizen science and ICT-based control and prevention strategies. NJAS-Wageningen Journal of Life Sciences 86:89-100. doi:10.1016/j.njas.2018.03.002

McLuhan M (2009). The medium is the message. In MG Durham and DM Kellner (Eds.), Media and cultural studies: Keyworks (pp. 107-117). New York City, NY: John Wiley & Sons.

Miñarro S, Reyes-García V, Aswani S, Selim S, Barrington-Leigh CP, Galbraith ED (2021). Happy without money: Minimally monetized societies can exhibit high subjective well-being. PloS one 16(1):e0244569. doi:10.1371/journal.pone.0244569

Miresmailli S, Bello-Bravo J, Pittendrigh BR (2015). Scientific Animations Without Borders and crowd-sourced emergency relief knowledge in local languages: A case study of the Iranian earthquake. The International Journal of Science in Society 6(2):1-12. doi:10.18848/1836-6236/cgp/v06i02/1-12

Mocumbe S (2016). Use of animated videos through mobile phones to enhance agricultural knowledge among bean farmers in Gurúè District, Mozambique. (MS), Iowa State University, Ames, IA.

Molia S, Bonnet P, Ratnadass A (2015). Support for the prevention of health risks. In J Sourisseau (Ed.), Family farming and the worlds to come (pp. 267-283). Dordrecht, Netherlands: Springer.

Mwangi M, Nakato V, Muthoni S (2007). Methods for disinfecting tools in management of banana xanthomonas wilt disease. Paper presented at the 8th African Crop Science Society Conference, El-Minia, Egypt.

Namara H (2018). Adoption of cattle manure for banana production by farmers in Mbarara district, Uganda. Kyambogo University, Kampala, Uganda.

Nannyonga B, Luboobi L, Tushemerirwe P, Jabłońska-Sabuka M (2015). Using contaminated tools fuels outbreaks of Banana Xanthomonas wilt: An optimal control study within plantations using Runge-Kutta fourth-order algorithms. International Journal of Biomathematics 8(5):1550065. doi:10.1142/S1793524515500655

Olsen W (2004). Triangulation in social research: Qualitative and quantitative methods can really be mixed. Developments in Sociology 20:103-118.

Ongu I (2014). Banana bacterial wilt being managed but at what cost? Retrieved 13 February, 2019, from https://www.newvision.co.ug/new_vision/news/1317725/banana-bacterial-wilt-managed-cost

Ouma G (2009). Intercropping and its application to banana production in East Africa: A review. Journal of plant breeding and crop science 1(2):13-15. doi:10.5897/JPBCS.9000088

ProMusa (2021). Xanthomonas wilt of banana: Modes of transmission. Retrieved 16 March, 2020, from http://www.promusa.org/Xanthomonas+wilt#Transmission_through_insects

Reynolds B, Seeger MW (2005). Crisis and emergency risk communication as an integrative model. Journal of Health Communication 10(1):43-55. doi:10.1080/10810730590904571

Rodríguez-Domenech MÁ, Bello-Bravo J, Pittendrigh BR (2019). Scientific Animations Without Borders (SAWBO): An innovative strategy for promoting education for sustainable development. Sustainability Science 14(4):1105-1116. doi:10.1007/s11625-018-0624-8

Rudel TK, Horowitz B (1993). Tropical deforestation: small farmers and land clearing in the Ecuadorian Amazon. New York City, NY: Columbia University Press.

Saldaña J (2016). The coding manual for qualitative researchers. Thousand Oaks, CA: Sage.

Sandel M (2012). What money can't buy. London, UK: Penguin.

Schmidt P, Stiefel J, Hürlimann M (1997). Extension of complex issues: Success factors in integrated pest management. St. Gallen, CH: Swiss Centre for Development Cooperation in Technology and Management.

Schneider F, Kallis G, Martinez-Alier J (2010). Crisis or opportunity? Economic degrowth for social equity and ecological sustainability. Introduction to this special issue. Journal of Cleaner Production 18(6):511-518. doi:10.1016/j.jclepro.2010.01.014

Shimwela MM, Ploetz RC, Beed FD, Jones JB, Blackburn JK, Mkulila SI, van Bruggen AH (2016). Banana xanthomonas wilt continues to spread in Tanzania despite an intensive symptomatic plant removal campaign: an impending socio-economic and ecological disaster.

Food Security 8(5):939-951. doi:10.1007/s12571-016-0609-3
Solnit R (2010). A paradise built in hell: The extraordinary communities that arise in disaster. New York City, NY: Viking.
Staver C, Van den Bergh I, Karamura E, Blomme G, Lescot T (2010). Targeting actions to improve the quality of farmer planting material in bananas and plantains-Building a national priority-setting framework. Tree and Forestry Science and Biotechnology 4(1):1-10.
Tata JS, McNamara PE (2016). Social Factors That Influence Use of ICT in Agricultural Extension in Southern Africa. Agriculture 6(2):15. doi:10.3390/agriculture6020015
Tinzaara W, Karamura E, Blomme G, Jogo W, Ocimati W, Rietveld A, Kubiriba J, Opio F (2011). Why sustainable management of Xanthomonas wilt of banana in east and central Africa has been elusive. Paper presented at the ISHS Acta Horticulturae 986 - VII International Symposium on Banana: ProMusa Symposium on Bananas and Plantains: Towards Sustainable Global Production, Salvador (Bahia), Brazil.
Tushemereiwe W, Okaasai O, Kubiriba J, Nankinga C, Muhangi J, Odoi N, Opio F (2006). Status of banana bacterial wilt in Uganda. African Crop Science Journal 14(2):73-82.
Wesolowski A, Eagle N, Noor AM, Snow RW, Buckee CO (2012). Heterogeneous mobile phone ownership and usage patterns in Kenya. PloS One 7(4):e35319. doi:10.1371/journal.pone.0035319
Zelizer VA (1996). Payments and social ties. Sociological Forum 11(3):481-495. doi:10.1007/BF02408389
Zelizer VA (2000). Monetization and social life. Etnofoor 13(2):5-15.