# Contending control over land: Farmer-firm relations in Mumias sugarcane belt, Kenya

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**Abstract**

Agricultural infrastructure and inputs are vital for productivity and resource conservation. Yet, negative outcomes of the supply and application of infrastructure and inputs for productivity and resource conservation exist. Control over agricultural infrastructure and inputs plays a determining role in whether farmers benefit from their lands or not. A qualitative study of the sugarcane industry in Mumias, Western Kenya show that farmers are highly dependent on various forms of infrastructure and inputs controlled by Mumias Sugar Company. Consequently, farmers have lost much control over their own lands and returns from their cane farms, to Mumias Sugar Company, resulting in frustrations over poor income and livelihoods. To this end, the paper suggests that besides land tenure, the control over infrastructure and inputs is even more potent to determine who benefits from land. In this respect, government, corporates, and farmers can collectively work to integrate infrastructure and inputs with farming, which is drawn from farmers' participation and lived experiences. It is expected that this integration will maintain the hold of farmers on these investments and guarantee their control over their lands and livelihoods.

**Keywords**: agricultural infrastructure, inputs, control, land, Mumias

## 1. Introduction

Land and related resources such as water, forests, soils, and minerals constitute the main resource for livelihoods in Africa. Capital and processes for controlling and harnessing land and its resources include land tenure, infrastructure, and agricultural inputs. These capital and processes are sometimes characterised by different and sometimes conflictive interests and power relationships that affect differently what the actors associated with a particular natural resource can derive from the resource. In this paper, an examination is done of sugarcane production in Mumias and the relationship of resource control and benefits that it entails, between farmers and Mumias Sugar Company (Mumias Sugar). The paper explores how control over infrastructure and agricultural capital inputs between farmers and Mumias Sugar manifests and shapes benefits that these actors derive from sugarcane farmland. Thus, the paper focuses on agricultural infrastructure and capital inputs together as a main medium through which contending control over land and its benefits between actors manifest. The paper contends that beyond the primary place accorded land tenure in determining the possessive power over natural resources and to benefit from them, control over land and its resources as much also is created and maintained through the ownership and control over infrastructure and agricultural inputs for harnessing resources. Ownership and control over agricultural infrastructure and inputs may even diminish the relevance of land tenure in determining who controls land and its benefits.

With primary data collected between April 2018 and June 2019, this paper demonstrates that incentives for sustainable harnessing of land and effective control over benefits derived from land are out of reach for local farmers, who are the landowners, due to their high dependence on infrastructure and inputs owned and controlled by Mumias Sugar. Though the sugarcane farmlands are owned by the farmers, their lack of control over infrastructure and inputs associated with sugarcane cultivation and processing means that indirectly the land is rather externally controlled by the firm. In this circumstance the sugarcane industry is extractive from farmers, while its benefits do not satisfy their needs nor conserve their lands. The control of Mumias Sugar over the major infrastructure and inputs in the sugarcane industry maintain frustrations of farmers directed at Mumias Sugar.

The control over land and its productivity is a major resource-based concern in academia, government, and in policy circles. Otherwise termed land tenure,[1] ownership and control over land are considered the most crucial domains to secure sustainable wellbeing for African farmers and landowners. Land policies across the continent reflect this concern. Yet, the integral linkage between agricultural infrastructure and inputs on one hand, and control over land on another, for farmers has escaped land-based discussions. Indeed, land and agricultural infrastructure have not ever been considered integral to each other. Rather, they are separated from each other in any analysis, and in this way societies lose the benefits of a more optimal benefit from lands they own. In this paper therefore, infrastructure and capital

[1] Land tenure refers to the conditions and institutional arrangements under which land is held, used and transferred (Cromwell 2002).

inputs in sugarcane production and processing is focused, to show how it mediates control over land and its returns for sugarcane farmers. The goal is to contribute towards agricultural policies for farmer-centred capital and infrastructural investments in agriculture.

## 2. Methods

In April 2018, while on a visit to a family in Esiakah near Mumias in Western Kenya, this researcher observed that sugarcane farmers talked openly about a number of challenges they faced in their relationship with the Mumias Sugar Company. Through informal interactions with some of these farmers, a main frustration that characterised farmers' daily lives was the low benefits they derived from the cultivation of sugarcane. From these initial interactions, the source of the farmer frustrations pointed to workings of agricultural inputs like fertiliser and associated processes of application, soil testing, ploughing, cane harvesting and transportation, and cane by-product recycling, all of which tended to compound debts and deprive them of sustainable benefits from their lands. Subsequently, more focused in-depth interviews were conducted among sugarcane farmers in Mumias from November to December 2018. These interviews sought to understand the infrastructure and inputs in sugarcane production and processing, who controls these capital inputs, how and why, and outcomes of this control for the livelihoods of farmers.

Mumias is located in the western part of Kenya (Figure 1). It is about 450 kilometres northwest of the capital Nairobi. Its economy is mainly rural with sugarcane production, maize, and vegetables constituting the main agricultural activities. Land is owned by families, and most farmers hold title deeds over their lands. The only sugarcane processing plant is the Mumias Sugar Company, a state-owned plant that buys sugarcane from farmers in the Mumias catchment and processes them into sugar for local consumption and export to neighbouring countries.

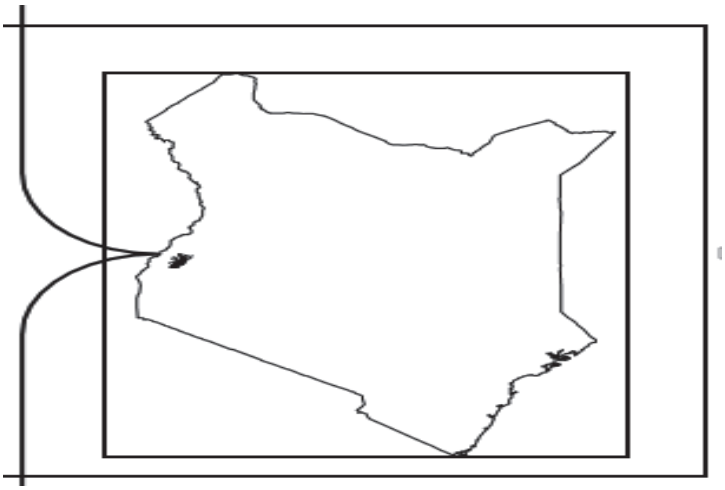

*Figure 1.* Map of Mumias sugar region, Kenya
Source: Adapted from Netondo *et al.* (2010)

In-depth qualitative interviews were conducted with mainly cane farmers and officials of Mumias Sugar. These interview partners were identified purposively, zeroing in on twenty-six farmers and three Mumias Sugar officials. Interviews were analysed with the aid of Atlas.ti, a qualitative data analysis software. The analysis was conducted as a form of coding various segments of data and hyperlinking related codes to form complex quotations or network views. Particularly, the network views enabled drawing out of themes from the individual and linked quotations.

It is acknowledged that the methodology followed could not generate results that can be applied to all temporal scales. Yet, it is precisely the reason that the results of this study constitute the frame and guide for a larger subsequent research on the same theme, in Ghana, Eswatini, and further in Kenya that takes into consideration the historical developments of agriculture in these countries. Nonetheless, this paper presents the results for Mumias as it exists between 2017 and 2019 and thus should be interpreted within this geo-temporal and cultural space.

## 3. Eminence of agriculture in African economies

Agriculture serves the backbone of most economies in Africa for transformation and poverty reduction. The confirmation of the place of agriculture in Africa invites various approaches to harnessing agricultural land and raising land productivity, including agricultural intensification and capital intensive investments (Waswa *et al*. 2012), alongside agribusiness-based industrialization especially with the high value cash crop sector (Yumkella *et al*. 2011). Associated with this capitalisation paradigm is the adoption of various forms of infrastructure and agricultural inputs to aid production and productivity of land. Agricultural capitalisation proceeds in Africa as though the interests of farmers and capital investors coincide to support the intensive harnessing of resources for yield maximization and profits. For instance, Waswa *et al*. (2012) writes that yield maximization is a most important pathway to profitable farming in Africa, where farmers are in control of input supply.

The contribution of Agriculture to growth and poverty reduction in Africa is essential. Yet, its outcomes for the conservation of natural resources and sustainability of farmers' wellbeing remain a challenge, especially where regulatory and legislative mechanisms are weak to control capital investments in natural resources. Degradation of natural resources through agriculture stem from activities of all actors but it is claimed that farmers are more to blame, especially where their income levels are low and unsustainable farming practice prevail (Olanipekun *et al*. 2019). According to this line of thought, improving opportunities for farmers to increase their incomes and reduce poverty and the degradation of their resources is a crucial policy consideration. But, the efficacy of agricultural and environmental policies in this respect have been limited, failing to establish a clear and holistic relationship between agriculture and the sustainability of natural resources and livelihoods (Mather 1996). The solution, it is argued, is to return to small-scale farming that employ traditional methods, with tested qualities to conserve natural resources while harnessing them. Using South Africa as his

focus, Mather (1996) notes that sustainability of natural resources in agriculture suffers from the hegemony of imported technology and infrastructure and divisive policies of the state that favour intensive capitalisation in Agriculture.

**4. Agricultural infrastructure and sustainability of livelihoods**

Pivotal to agricultural intensification and transformation is infrastructure. In agriculture, infrastructure is defined as the physical structures, equipment and tools, processes, services, human capital and social networks which enable systems and enterprises to function effectively (Brenton *et al*., 2018). In Fulmer (2009) and Yu (2012), cited in da Silva and Wheeler (2017), infrastructure refers to all elements of interrelated systems that provide goods and services essential to enabling, sustaining or enhancing societal living conditions. For much of human history, infrastructure has mediated between humans and their natural environment (Chester *et al*. 2019). It is obvious in the conception of infrastructure that human prosperity requires infrastructure. This places control of the outcomes of agriculture in the hands of those who own, operate, and manage infrastructure and agricultural inputs to manipulate processes to their interests.

Agricultural infrastructure and inputs are redefined in this paper as physical, social, and political tools and services that not only provide benefits from natural resources to humans, but also equally are media through which humans protect and conserve these natural resources. Within the sugarcane producing industry, agricultural infrastructure and inputs include physical materials and processes such as recycling products and systems, communication channels, soil and water testing, ploughing, fertilizers and fertilizer application, and cane harvesting. Infrastructure and inputs in agriculture must be integrated with conservation of natural resources for sustainability of livelihoods. The integration will work by farmers participating in the formulation, supply, and application of the infrastructure and inputs, based on their long-evolved experiences, to benefit equitably from harnessing resources. I contend that these infrastructure and inputs can be integrated into traditional modes of agriculture where farmers work the land mainly from their wealth of experiences. The integration of capital inputs with traditional modes of agriculture does not replace farmers' experiences and knowledge about their farming. I envision that integration will add on to them. For instance, inorganic fertilizers, rather than replacing traditional mulching and incorporation of cow dung and rotten matter into soil, can rather be applied in supplement with organic fertilization. Also, rather than entire harvesting of cane and recycling cane husks into molasses and bagasse, harvesting and processing can return pulp onto the land where farmers can plough back into the soil. Trees can be planted in-between sugarcane in one field, rather than the monoculture (Lindell *et al*. 2010), which is foreign to home practice. Farm extension and information services can be provided to farmers through their peers and not external agents. Labour-intensive farming can also be adopted where labour is abundant, in place of the hegemonic infrastructure and technologies of powerful actors (Waswa *et al*. 2012). These measures, will provide farmers control

over their lands and to determine how infrastructure and inputs are applied to their land to conserve them. Farmers gain control over infrastructure and inputs, even if they do not own it.

Chester *et al*. (2019) argue for a concerted integration of infrastructure with nature to save the planet earth. They note that the Anthropocene is here and evolving into complex systems of relationship between man and the natural environment mediated centrally by various forms of infrastructure. Thus, disciplines and knowledge on infrastructure must adapt and evolve as well to take care of the growing complexity of changes affecting the natural environment from the actions of humans. To this end, infrastructural design and application needs to adapt and change with or ahead of changing social and environmental systems so as to ensure conservation of resources (Chester *et al*. 2019). Reid and de Sousa (2005) also alludes to the negative outcomes of separation of infrastructure from sociocultural conditions of natural resources when they note that the current process of environmental impact assessment, which indicates a conflictive relationship, is superficial and does not at all address any integration of infrastructure with the environment. Both of these literature and a host more others follow the general narrative of a conflictive relationship between infrastructure and environmental conservation. The authors question environmental assessment as a way of ensuring compatibility of infrastructure with conservation goals. They agree that there is need for deeper integrating between conservation and infrastructure planning.

The necessity of integrating infrastructure with nature as a way of enhancing farmers control over their lands and livelihoods is based on the notion that infrastructure is in a conflictive relationship with the natural environment, which must be resolved. In Reid and de Sousa (2005) the conflict relationship is alluded to. Infrastructure consumes resources through harnessing for human needs and thus destroys natural resources in the process rather than provide services to conserve it. Environmental licensing, environmental compensation, and, to a lesser degree, fines are important regulatory instruments that supposedly mitigate the negative outcomes of infrastructure on the environment (Reid and de Sousa 2005). Yet, it can be argued that these legal instruments often remain weak or unenforced due to state inaction, to provide for all actors to equitably benefit from them. The model of infrastructure in agriculture being advocated for in this work, is to link the operation of infrastructure to clear conservation of natural resources and through which farmers gain control these infrastructure.

Departing from the conflictive model of the relationship between infrastructure and the natural environment, is the perspective that infrastructure and the environment are actually one and the same thing. For instance, da Silva and Wheeler (2017) write about ecosystem as infrastructure and note that what constitutes infrastructure should transcend only all human-made assets, to include ecosystems as a type of infrastructure. For da Silva and Wheeler (2017) considering the ecosystems as infrastructure is a powerful way of integrating different agendas including climate mitigation, biodiversity conservation, and sustainable production and consumption. Infrastructure is no longer, or cannot afford to be, separated from nature - in many ways, the dichotomy between infrastructure and the natural

environment no longer exists; they are one and the same (Chester *et al*. 2019: 1009). Mistakes must be avoided, such as avoiding excessive capital intensification in agricultural production that produces high dependence of farmers on infrastructure and inputs over which they have little knowledge and control. Traditional forms of agriculture with capital inputs must be developed by all actors, including through state research and development. Traditional forms of agriculture do not preclude infrastructural development but rather grounds it to provide continuous flow of services for man but also to nourish the natural environment (Mather 1996).

## 5. Farmer – firm relations in Mumias

Control over infrastructure and inputs significantly determine access to and control over land in the sugarcane industry in Mumias. Fieldwork in Mumias among sugarcane farmers shows that most farmers inadvertently cede control over their lands to Mumias Sugar. This occurs in two sets of processes. First, Mumias Sugar contracts the lands on which sugarcane is grown for a period of time. Within this period of time, which is usually about 50 months at least, most major agronomic activities, including the supply of inputs such as fertilisers, seeds, ploughing, harvesting, transportation among other, are controlled by Mumias Sugar aimed at attaining high productivity of the farm. An excerpt of this is presented below:

> **53:1 D: #00:01:42-0# No, you see first of all the company contracts the far… (1090:1369) - D 53: Male farmer1_feb2018**[2]
>
> D: #00:01:42-0# No, you see first of all the company contracts the farmers. So that means it owns the plots for the contracted time, that is, three cuttings. And each cutting is approximately 18 months, so 18 months times three is when the contract expires, usually. #00:02:20-3#

> **136:1 KD: You start by ploughing the farms. In the beginning the company wou…… (1339:2186) - D 136: Third round interviewer3**
>
> KD: You start by ploughing the farms. In the beginning the company would send tractors to come and plough the land. Afterwards the company would also do the harrowing. Afterwards they would supply one with seeds depending on the size of the

[2] At the begining of each quotation used in this report is an Atlas.ti quotation ID for any particular quotation used. The ID consists of the document number and a number indicating the chronological order when the quotation was created. For example **53:1 D: #00:01:42-0# No, you see first of all the company contracts the far… (1090:1369) - D 53: Male farmer1_feb2018**, can be interpreted as follows:
'**53:1**' means the quotation used is the first quotation from Document 53 uploaded to the Atlas.ti software for this paper; '**D: #00:01:42-0#**' is a time stamp generated from the transcription software that indicates position of the sentence in the audio tape; '**No, you see first of all the company contracts the far…'**. is the beginning few words of the quotation; **(1090:1369)'** means the quotation starting from the 1090nd character of the page and ending with the 1369th character of the same page; **D 53: Male farmer1_feb2018**
is the name the author gave to the code, and the date the interview from which the quote was taken, was conducted.

> farm. They would later supply the farmer with fertiliser called DAD. When the cane is grown up to the height of one's knee the company supplies another fertiliser called Urea as well as DAD. The sugarcane would then be harvested after 14 months. The company would equally send labourers for the cutting/harvesting. Afterwards they would transport the cane to the company and later the farmer would be told to go and sign a statement. This statement indicates that sugarcane has been delivered. It is also done to ascertain that the tonnage at the company is the same as the one done on the farm at harvest.

Second, the system of contract farming and input supply has produced sugarcane farmers who are highly dependent on Mumias Sugar and thus have lost control of the outputs from their lands. Farmers find themselves in a relationship with Mumias Sugar that is characterised by frustrations and debt. Quotations pulled from interview transcripts are networked to demonstrate this dependence, exploitative, and frustrating relationship:

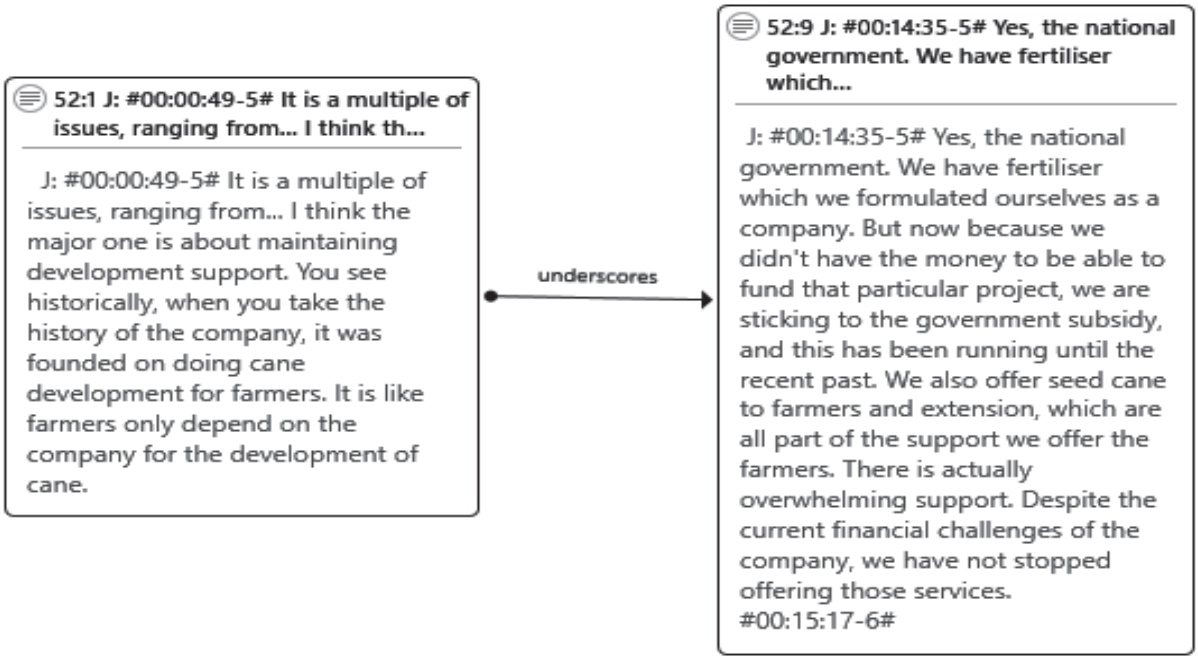


*Figure 2*. Farmer dependence on Mumias Sugar

These quotations in Figure 2 show that Mumias Sugar confirms its supports for farmers with various forms of infrastructure as inputs for which farmers pay. Farmers have become highly dependent on these infrastructure and inputs though their control over them is indeed minimal, resulting in their frustrations over the impacts of these infrastructure and inputs on yields, as evidenced below (Figure 3):

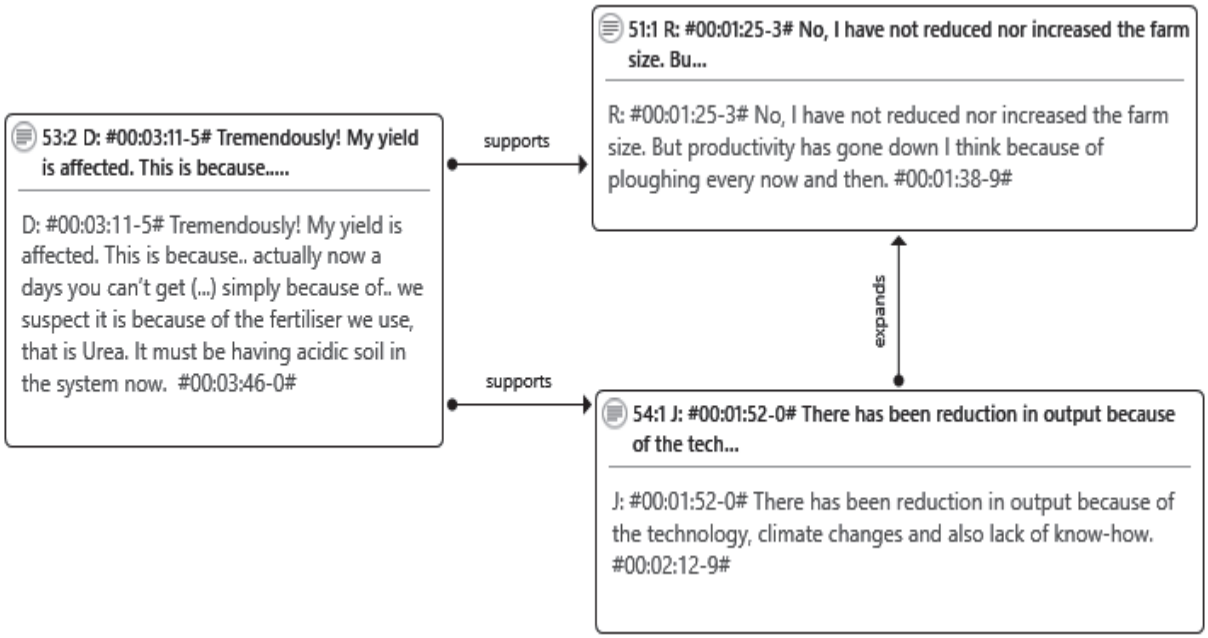


*Figure 3.* Farmer frustrations over farm yield

In Figure 4, farmers are most often in debt because major agronomic activities including soil testing, ploughing, harvesting, transporting, and major inputs such as cane seedling development, fertiliser, are supplied by Mumias Sugar and their applications directed, but costs of these are unilaterally set by the company and deducted from farmer incomes. Moreover, as respondent 'R' said in Figure 4 (right hand quote), sometimes farmers' canes do not even reach the factory but Mumias Sugar does not take responsibility for this even though it does the transportation of cane from farm to factory. The situation is one of exploitation and extraction of the land and human resources of the farmers. But why do farmers still keep producing sugarcane? It is because of their high dependence on Mumias Sugar that has led to lose of farmer confidence to diversify and adopt alternative farming approaches to that of Mumias Sugar.

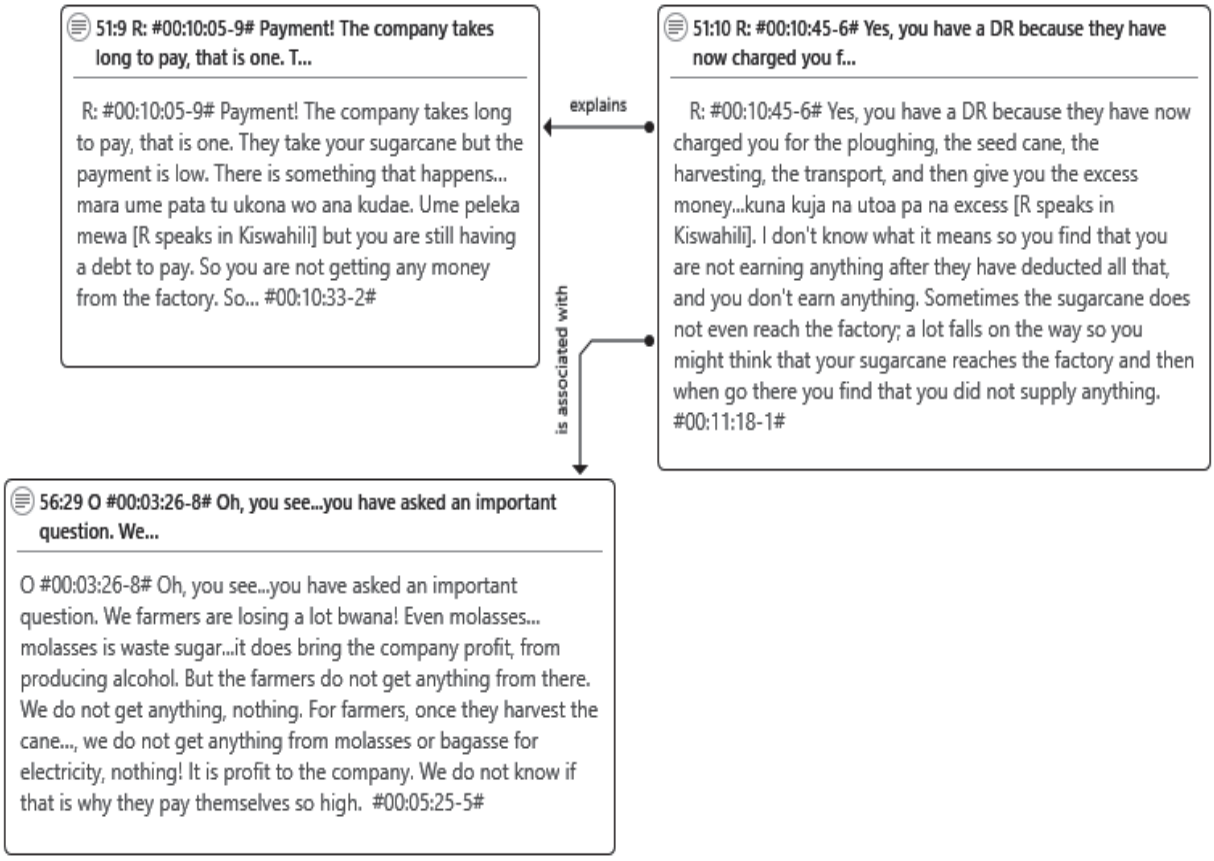


*Figure 4*. Farmer persistent indebtedness

Farmer persistent indebtedness in Mumias is no different from findings of Waswa *et al*. (2012) elsewhere in sugarcane plantations in Kenya, this indicating that difficult economic condition of farmers is widespread:

> **42:3 only the companies benefit from other by-products of sugar processing…… (2:1992 [2:2404]) - D 42: Lit_Contract cane farming in Kenya**
>
> …only the companies benefit from other by-products of sugar processing such as co-generation, sale of molasses, and energy savings through the use of baggase in boilers. This disparity in income distribution appears to be one of the key contributors of poverty among sugarcane farmers, who incidentally find it psychologically difficult to diversify to other potentially viable crops (Waswa *et al*. 2012).

Ironically, farmers have not established any functional cooperative organising to mobilise their numbers into resistance to the farming approach controlled by Mumias Sugar. Rather, the dependence on Mumias Sugar for infrastructure and inputs creates unhealthy rivalry and petty theft between farmers (cane poaching). Some farmers complain of theft on their farms. Moreover, each farmer takes individual

actions as they deem fit, to confront Mumias Sugar, such as refusal to sell cane to the company even though they may have been supplied with farm inputs (Figure 5):

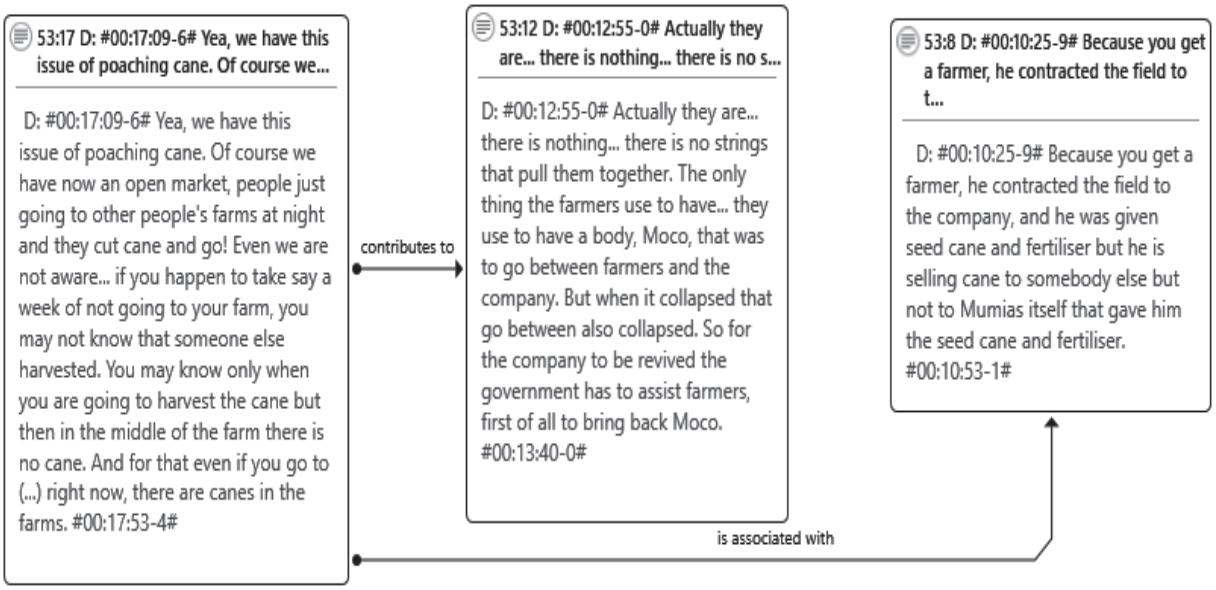


*Figure 5*. Farmers' bold confrontation with MSco.

The high farmer dependence on Mumias Sugar for inputs as demonstrated in the quotations above, paves way for their loss of control over their lands at least during the period they cultivate sugarcane and supply to Mumias Sugar. All the transcript quotations analysed together demonstrate that farmers and Mumias Sugar hold grievances against each other, and this is largely the result of the mediating role of infrastructure and inputs in developing what farmers lament is unfair access against them, to the benefits from cane production.

## 6. Discussion

From the analysis of the field data, it is contended that agricultural infrastructure and inputs are a powerful mechanism that can strongly mediate control over and benefits from natural resources. The revelation is that land tenure alone is not the solution guaranteeing control over resources for farmers who own land. Rather, infrastructural and input tenure (ownership of, interest in, and power over infrastructure and inputs) count significantly. The solution to farmers' challenges in their relationships with Mumias Sugar is integration of agricultural infrastructure and inputs with traditional modes of agriculture that is, in such a way that the design and operation of infrastructure and inputs is based on participation and experiences of farmers built over years of owning land and farming. Farmers' concerns over land transcends food security to life-long values such as preservation of land for the family cohesion. Thus, the integration of infrastructure and inputs with farming is farmer-centred agriculture. It can be even more sustainable than the profit-oriented approach of capital intensification since farming aligns

more with the values of farmers. To this extent, this paper disagrees with studies on the sugarcane industry in Kenya that suggest that farmers can improve their economic and social situations mainly through the empathy of the sugarcane firm; that to change the situation of farmers the solutions should be firm-centred (Owino *et al*. 2018, Waswa *et al*. 2012, Olanipekun *et al*. 2019).

Finding solutions to the challenges of farmers in the sugarcane industry can be advised from a sociocultural, political, and conservation approach, rather than economic. In agreement with Mather's (1996) analysis, the adoption of traditional modes of farming that hold prospects for conservation and at the same time reducing dependence of farmers on high capital intensive infrastructure will provide hold of farmers on their livelihoods and resources. In the pursuit of agricultural intensification in countries like Ghana and Kenya, local expertise in harnessing resources that conserve these resources are being replaced by capital intensive production such as intensification of fertilisers, herbicides, and modern machinery (Tamru *et al*. 2017). But the negative conservation and welfare implications of farmers have tended to erode any gains made from agricultural intensification and capitalisation to improve wellbeing of farmers.

While cash crops like tea and sugarcane have contributed to deforestation in Kenya and farmers are staggering along under the effects of degradation of their resources, simple agroforestry practices in sugarcane farming, in place of exclusive dependence on inorganic fertiliser (controlled by agro-processing firms) can lead to significant changes in the farmer-firm relations and equity for farmers in outcomes of their livelihoods (Lindell and Kroon 2010, Jaynea *et al*. 2019). Unlike other studies that focused exclusively on economic factors, Lindell and Kroon focused on traditional, local and inexpensive modes of agriculture that ensure environmental sustainability as the surest way to solve challenges of farmers in the sugarcane industry. Agro-forestry is no stranger to traditional ways of farming before introduction of capital intensification. I align with this alternative paradigm and a return to sustainability for the sugarcane production industry. It is contended that though some loopholes still exist which can erode any benefits, the collective and statutory recognition and promotion of traditional, alternative forms of agriculture, can help address the degradation and conflictive outcomes of agricultural infrastructure and inputs. This is so because for infrastructure and inputs to conserve resources, they must become the natural environment itself; one and the same (Chester *et al*. 2019). Such effective integration of infrastructure and inputs with the natural environment is feasible through concerted policy. In this regard, national policy action is needed to bring this integration about and make infrastructure work especially for poor people (Cromwell 2002).

Inasmuch as the studies on the Kenyan sugarcane industry share informative insights on the difficult conditions of farmers (Owino *et al*. 2018, Waswa *et al*. 2012, Olanipekun *et al*. 2019), they fail to recognise that infrastructure and input provision if controlled by dominant economic interests beyond farmers' control, can be detrimental to yield, natural resources, and farmers' wellbeing, through intensive extraction. Indeed, unfortunately these studies construct farmers as passive people, and that

due to their low incomes, farmers have little resources to afford efficient conservative techniques and practices of their own; in other words, these studies fail to identify the forces of control beyond income, but rather identify that farmers by their generally low incomes lack environmental consciousness.

Refreshingly, the case of Malawi is quite contrary to the construction of farmers as passive clients and lacking environmental experiences (Spencera *et al*. 2018). In their work, Spencera and colleagues contend that contrary to the dominant quantitative research findings that farmers are highly willing to pay for extension services, the context of Malawi, through a qualitative longitudinal study found that smallholder farmers though want to pay for extension services, see themselves, and should be related to as such by extension providers, as possessing capability to decide on and utilise extension service in ways that fit their peculiar conditions to enhance productivity and conserve their resources. Thus, farmers are not just willing to pay for and depend on extension service providers. Governments are crucial to provide access of all farmers to extension service supply on how and when they want to utilise such services. Malawian farmers are resisting the user-pay approach to agricultural extension due to insensitive, expensive services that do not lead to their wellbeing, this bringing the question of legitimacy, salience and credibility to bear on user-pay approaches, without government intervention, in agricultural extension and input provision.

Considering the environmental degradation in Mumias in Kenya found in this study and also in Lindell and Kroon (2010) and Jaynea *et al*. (2019), it is rather corporates and rich and profit-oriented businesses and farmers who employ exotic agricultural technology, infrastructure, and inputs that pose the real destruction to African environmental resources. Of course local farmers do not lack skills to effect conservation changes to the environment. It is rather their loss of control over high infrastructure and inputs, translating into loss of control over their lands as demonstrated with the quotations above that is the real issue. Constructing farmers as poorly skilled is oblivion to the wealth of experiential skills that farmers acquire over the years and which if recognized and incorporated into capital intensive agriculture can release them from the unproductive, extractive control of modern modes of agriculture.

## 7. Conclusion

Infrastructure and inputs are useful tools for harnessing and conserving natural resources. However, they can also act as a disempowering or inhibitive forces that deprive conservation of natural resources and derivation of desired values from land. It is therefore critical that capital intensive approaches to agriculture promote, rather than inhibit, the development of sustainable agriculture that meets the social, economic, and political needs of farmers and not only firms. To help identify socioeconomic and political contexts of local farmers to inform infrastructure and input design and integration with agriculture, citizen's involvement in generating, analysing, and developing knowledge (citizen science), in complementary to state and private businesses researches, is clearly the way to go. Farmers, the state, corporates, and community-based groupings should constantly accumulate date on the outcomes of

agricultural infrastructure and inputs for local people so that any undesired outcomes can be corrected for sustainability of livelihoods and environmental resources.

It is clear from the analysis presented in this work that modes of agriculture that push costs of farming to farmers without developing their capacities to be independent of exploitative interests destroy livelihoods and agriculture. In this context, government policy is a powerful tool to determine the direction and character of agriculture and the place of infrastructure and inputs. The issues confronting the relationship between farmers and firms means that control of local farmers over their lands and for the sustainability of their livelihoods cannot be left in the hands of firms alone. Involving farmers in the design and application of agricultural infrastructure and input will have high ecological, social, and political positive impacts for all actors.

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