

Hebinck, P.; Bosma, L. and Veldwisch, G.J. 2019. Petrol pumps and the making of modernity along the shores of Lake Victoria, Kenya. *Water Alternatives* 12(1): 13-29



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## **Petrol Pumps and the Making of Modernity Along the Shores of Lake Victoria, Kenya**

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**ABSTRACT:** This paper explores how pump irrigation has evolved along the Kenyan shores of Lake Victoria. Over the past two decades access to petrol pumps has allowed small-scale horticultural enterprises to start up and then transform the size, intensity and nature of their production. We analyse the spread of petrol pumps as the assimilation and wider use of a modern device along a mutated trajectory of change. We argue that it was not led by external actors but is a local and self-organised process driven by actors who negotiated interfaces between themselves and those operating at the macro level. The assimilation unfolded not as a temporally and spatially linear process but through its embeddedness in complex and dynamic social relationships that structure access to the key resources required for vegetable production. This in turn has given rise to a range of strategies in which the pumps' performance is adjusted to fit with various socially differentiated contexts.

**KEYWORDS:** Horticulture, farmer-led irrigation, mutant modernity, farming strategies, pump irrigation, Lake Victoria, Kenya

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### **INTRODUCTION**

The paper explores the changes in the organisation of horticultural production in western Kenya that are due to the introduction and diffusion of mobile petrol pumps within the region. Over the years this has allowed horticulture to evolve into an important sector that increasingly provides an alternative livelihood for many people, and which, in turn, has fuelled an expansion and deepening of the regional commodity economy. The fisheries upon which people depended for their livelihood over the last two centuries are diminishing due to a combination of overfishing and the introduction and spread of predator fish species such as the Nile Perch (Medard et al., 2015).

Petrol pumps have played a significant role in the process of livelihood transformation, socially and economically, as well as technically. Pump irrigation has largely – if not fully – replaced the original bucket irrigation system as a way of taking water from the lake (Geheb and Binns, 1997). The petrol pumps have facilitated the intensification and transformation of horticultural production similarly to the way the ox plough transformed field cropping in the 1930s in Southern Africa (Boserup, 1981). In theoretical terms, the spread of the use of petrol pumps represents the assimilation of modern devices. In this paper we argue that modernisation is not dictated by external actors but is a process that is self-organised at the local level by actors who negotiate the interfaces between themselves and those

operating at the macro level (formal and informal agricultural traders, pump mechanics, etc). It also entails finding ways to deal with the new materialities of their vegetable-growing operations.

Arce and Long (2000a,b) coined the term 'mutant modernity' to describe self-organising practices. It is a pattern of modernisation that emerged as an important theoretical theme in development sociology (Robins, 2003; Escobar, 2003, 2005; Long, 2012; Masco, 2004). Mutant modernity provides an appropriate lens for describing the development processes that are occurring along Lake Victoria's shores. The horticulturalists are playing a key role in shaping socio-technical configurations by appropriating the petrol pumps and making them central to their labour process. These petrol pumps found their way to the shores of Lake Victoria and spread through social relationships, patterned by seniority and kinship, the hierarchies of which were later challenged by a younger generation. These relationships shape a range of different farming strategies, centred on access to land and money, which shapes the possibilities of purchasing or hiring petrol pumps. Seniority also brings an element of time to the analysis. The elders control the land and the means of acquiring the pumps, both of which are prerequisites for the development of irrigated horticulture. The strategies we identify are a manifestation of agrarian development trajectories that are structured by a combination of the generational hierarchies and the opportunities for, and limitations to, participating in the commodity economy. These strategies also reflect processes of social differentiation within the regional economy of Luoland, which are not necessarily based on class but on building alliances and cooperation (Cohen and Atieno Odhiambo, 1989; Hebinck and Mango, 2008; Hebinck et al., 2015). These relationships, as we show, create new dependencies between the vegetable growers and those who control capital, land, labour and pumps while simultaneously opening other avenues to access the key resources.

Interestingly, there has been little, if any, involvement by governmental or non-governmental organisations (NGOs) in this process. It was the farmers cum fishermen who, together with local shopkeepers, saw the transformative potential of this new irrigation technology. Local shopkeepers started to import petrol pumps from India and China, which they sold relatively cheaply to individual horticulturalists, who began to deploy them. By emphasising the mutant modernity of this trajectory, this paper casts a new light on the role that farmers play in developing irrigated agriculture by tapping into resources that become newly available and accessible through evolving macroeconomic and technological relations, in this case with India and China.

It is these African smallholder farmers who are driving the establishment, improvement and/or expansion of irrigated agriculture in the region – a process that has come to be known as farmer-led irrigation development (FLID) (Nkoka et al., 2014; Beekman et al., 2014; Woodhouse et al., 2017). In several African countries the irrigated area developed under FLID is estimated to be as large as, or larger than, the irrigated area recognised in government statistics (De Fraiture and Giordano, 2014; Beekman et al., 2014; Woodhouse et al., 2017). Recent estimates of the actual irrigated area derived through remote sensing are several times larger than the official statistics by a factor of 2-3 for sub-Saharan Africa as a whole and in some countries by a factor of up to 14 (IWMI, 2016). The potential expansion of the irrigated area through such processes rivals that of investments in large-scale irrigation (Theis et al., 2018). To date, FLID and its dynamics have largely been ignored by development agencies and the state. Driven by a state- and expert system-led modernising development agenda (see De Bont et al., this issue), the planning of irrigation has been primarily top-down. The experiences of irrigators and the ways in which they can re-work and adapt irrigation technologies are not taken into account. FLID therefore challenges the state- and science-driven models of irrigation development in terms of design and market dynamics, as well as of organisational and institutional embedding.

We begin this paper by summarising our conceptual starting point. We then present a concise summary of the FLID literature, which we combine with an analysis of the social organisation of the Luo and the importance that Luo culture attaches to maintaining a generational balance. Both are central components of our investigation. We then summarise the agro-ecological processes and rural transformations in the region, which are essential elements of the drive to expand horticulture. The

sections that follow describe the various strategies that horticulturalists have used to access and utilise the pumps. In conclusion, we highlight the importance of generational control and show how pump irrigation provides opportunities to circumvent it through the diversity of ways in which the pumps are accessed, used and adjusted to horticultural production practices.

### CONCEPTUAL FRAMING AND DATA COLLECTION

While farmer-led irrigation development is a process characterised by the centrality of irrigators, other actors are also involved: craftspeople, agro-dealers and traders, agriculture extension agents, local and national policy-makers, irrigation engineers, civil society and development aid agents. Substantial tracts of land in the area around Lake Victoria are being brought into irrigation through FLID. One of the ways in which this occurs is by vegetable producers acquiring small, mobile (petrol) pumps to lift water (from both open water bodies and groundwater). Most studies, however, have focused on this as a particular form of irrigation defined by the use of a pump rather than by the development processes involved (see for example Burney et al., 2013; Namara et al., 2014; Dessalegn and Merrey, 2015).

We understand FLID as a modernity-making process that is initiated and shaped by irrigators themselves and which has significantly transformed irrigation practices. In describing this pattern as 'mutant modernity', Arce and Long (2000a) emphasise the endogenous, creative and self-made nature of these transformations. Characterising them as 'social mutations' and their actors as 'social mutants' (2000a: 17-18), they describe the social processes that evolve as the new devices, such as pumps, are used.

Our case study of vegetable irrigation in West Kenya shows that FLID was not designed by engineering science or suppliers' marketing strategies but is a self-organised process that is embedded in, and formed by, complex social relationships and struggles between different actors. We thus need to take into account the type and nature of social relations in which irrigation becomes embedded. Pumps, like mobile phones and other electrical devices, are manifestations of 'modernity' (as something that is external and originally Western) that are gradually being incorporated into the social lives of people in the Global South. The 'modern' is finding its way into African homesteads in the form of devices that lead to changes in traditions, practices and social relations but in different ways, as we will show. As a modern device, the petrol pump generates different embodiments, implying that there is no fixed or clearly defined 'modernity'. As Arce and Long point out,

[properties, ideas and practices] are constantly dismembered, consumed, recycled or excreted through the processes of everyday life and experiences. In this way, the properties of modernity are constantly constituted and refashioned in their interaction with diverse other modes of organisation, rationalities and artefacts. Clearly, in the understanding of these processes, we must give attention to situations in which meanings and values are contested, allocated and constantly reappraised (2000b: 160).

Hence, there is no direct relationship between the initial ideas behind the new technological constructs and the ways in which they become embedded into certain contexts. This approach to studying the spread of technological innovation is in stark contrast to the linear process of 'adoption', as in the much-followed theory of innovation diffusion originally developed by Rogers (1962).

FLID emerges as a form of mutated modernity established by the irrigators themselves, who attribute their locally shared meanings and rationalisation to this irrigation method. In the fields along the shores of Lake Victoria we identified four different strategies of petrol pump irrigation. We understand these to be specific examples of trajectories of agrarian change based on how local actors

(i.e. irrigators or vegetable growers<sup>1</sup>) have effectively assimilated petrol pumps into their everyday practice. At the aggregated level of the region, each strategy represents a different social and technical expression of the development of vegetable growing enterprises along the shores of Lake Victoria. In all these expressions the irrigators play a key role and are subsequently treated here as social actors (Long, 2001, 2012). They exercise their strategic agency to find ways to initiate and expand irrigated vegetable production and enter the horticultural sector. Central elements of these strategies include gaining control over land and labour, acquiring the money needed to purchase or hire a pump for irrigation and identifying markets to sell their products. In analytical terms, these strategies are the product of how social actors negotiate the interfaces between actors operating in vegetable production per se (farmers, family members, friends, labourers) and those operating upstream and downstream from production (shopkeepers, marketers, input suppliers, etc). Negotiating reciprocity and family obligations are central components in operating multi-sited livelihoods that straddle different spaces and entail a variety of activities.

### EMBEDDING OF MODERNITY IN LUOLAND

When debating the dynamics of FLID it is essential to recognise that the dominant relations of kinship that structure access to land, capital and labour are not static or fixed but can be subject to change. Thus we need to keep an eye on changing livelihoods along the shores of Lake Victoria, and particularly those that trigger new social relations of production and inherent dependencies. The latter implies that we need to contextualise and analyse vegetable production – and more broadly FLID – as occurring in a space of struggle for, and over, resources. The new social processes that these dynamic and volatile conditions bring about are important aspects of processes of mutational change. Clearly, in seeking to understand these processes it is equally important to take into account that the spread and use of petrol pumps and the expansion of irrigated vegetable production have been shaped by two external factors: the lake becoming a less reliable source of fish and the growing demand from nearby towns and local marketplaces for commercially produced vegetables. These processes form the background to understanding mutational change along the shores of Lake Victoria.

Before drawing on local accounts and interpretations of land-people relationships, customary rights and laws and kinship relationships we briefly characterise how the Luo order their social life based on earlier research (Hebinck and Mango, 2008). We interpreted these observations with reference to existing ethnographies (Southall, 1952; Ogot, 1967; Cohen and Atieno Odhiambo, 1989; Shipton, 1992). We then draw on data from field research among horticulturalists from five lakeside villages in West-Uyoma conducted by the second author between September and December 2014, when he stayed in a centrally located village in the area (see Figure 1). The methodology consisted of a combination of semi-structured interviews and (participant) observations of irrigators, traders, technology providers and other key informants. A total of 67 interviews were conducted (aliases are used in this article). We also mapped the irrigated areas, observed irrigation and pump-use practices and measured pump capacities.

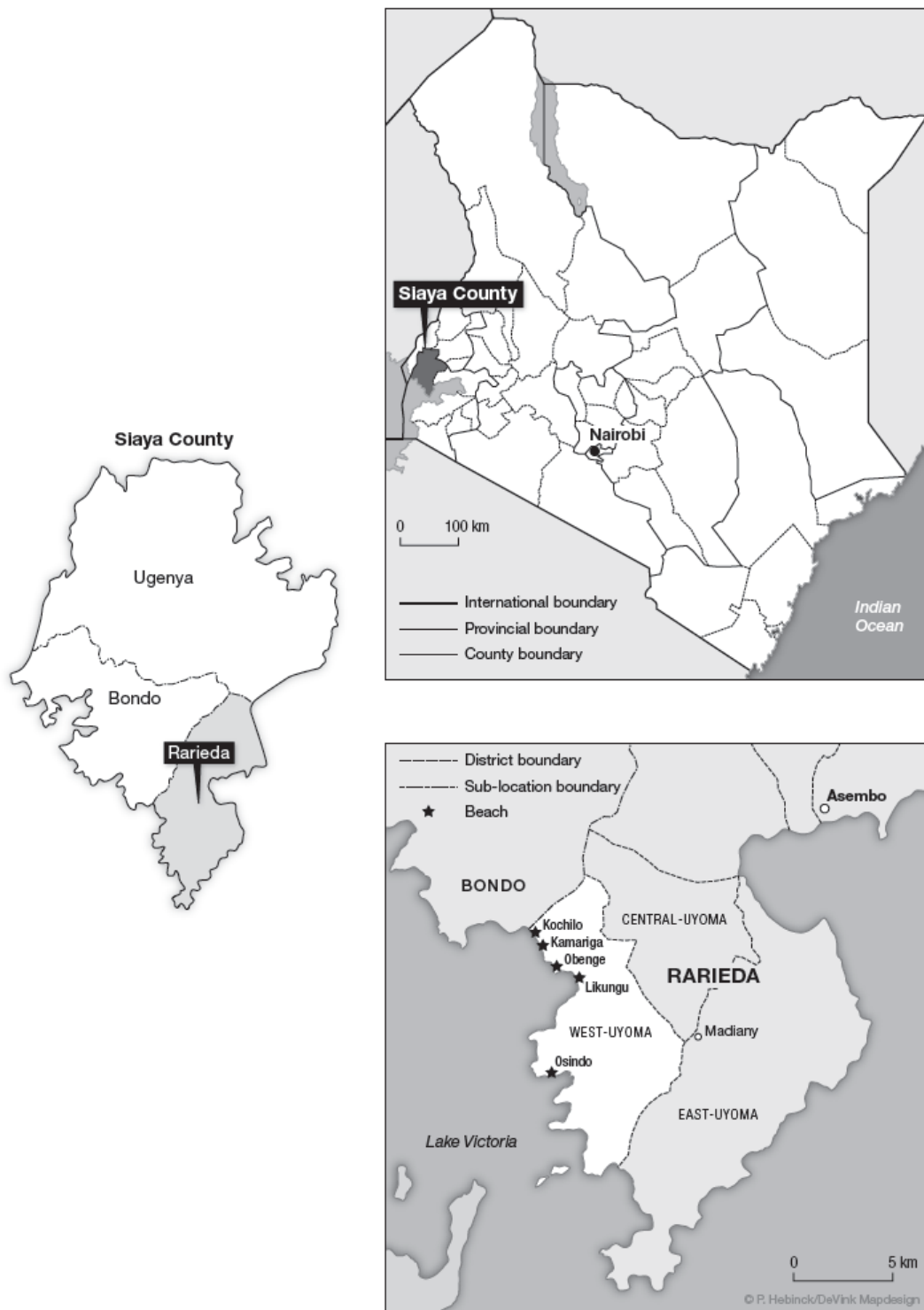
Analysing kinship and other types of social relationship requires knowledge of how the Luo have settled over the years (Hebinck and Mango, 2008: 42-44). Existing accounts reflect an almost idealised version of the social life of the Luo. A (typical) homestead (*dala*) consists of a site where the domestic group built its houses, which is generally surrounded by their fields. The smallest social unit in the homestead is the 'household', usually consisting of at least two generations – the father and mother(s) and their offspring. Several homesteads make up a *gweng* and resemble villages or settlements.

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<sup>1</sup> We specifically avoid terms such as 'farmers' because of the inherent complicating assumptions that the notion carries. When ordering and interpreting vegetable producers' experiences and motivations with the use of pumps, we have avoided, as Latour (2005) advises, making a priori distinctions between 'rich' and 'poor' or between 'powerful' and 'powerless' or 'witchcraft' and 'wisdom'.

Residence in a village, as Southall (1952: 27) also noted, is based upon kinship – more specifically people descended from the same grandfather (*Jokakwaro*) – but also upon alliances developed out of strategic considerations (Cohen and Atieno Odhiambo, 1989: 14). This settlement pattern remains significant and recognisable today.

Figure 1. Map of Kenya and location of study sites.



The elementary social relationship is patrifocal, which cements the relationships between father, mother and their children. Referred to as *jokawuoro* ('people of the same father'), they operate as one group, sharing and distributing most domestic activities. Marriage and inheritance are intertwined and shaped by seniority, which requires that the eldest son marries first, then the second eldest and so on; the pattern is the same for the daughters. Seniority also results in the elderly men in the *dala* controlling the land and its resources. It is also reflected in the culturally shared practices of sowing and harvesting: the eldest person in the *dala* must plant (*golo kodhi*) and harvest (*dwoko cham*) first. The same applies to the eating of specific (usually the best) parts of a slaughtered animal or fish that have been caught.

If Luo society were only ordered this way, the spread of petrol pumps would simply reflect the dominant role of the elders in the use and control over land and capital to purchase the pumps. Yet, social relationships change over time; seniority may be contested, and customary arrangements are subject to adaptations and deviations. Caution must be exercised with regard to the accounts from which we draw our interpretation of social and technological change, which, as we have argued elsewhere (see Hebinck and Mango, (2008) and Hebinck et al., (2015)), suggest a shared and unchallenged notion of customary and kinship relationships and law. The growing use of petrol pumps cannot be understood without analysing how younger men have actively sought alternative ways to access land and money, thereby challenging the seniority and embedded role and position of their elders. Our case material shows that some of the pump-irrigators started their vegetable irrigation operations by forging alliances with peers and/or friends rather than elders and managed to acquire land and capital through networks outside the elders' control. Temporary labour migration and access to good education provided avenues for many to access the resources to purchase land and pumps and to hire labour for irrigated vegetable production. In other words, the conditions that facilitated vegetable irrigation along the shores of Lake Victoria are customary social relations of kinship and seniority as well as the social struggles of a younger generation seeking to access resources that are outside the control of elders.

Taking this a step further to the level of trajectories of agrarian change, we found that the spread of pumps out in the fields has not been a homogeneous or linear process but is highly differentiated in time and in terms of the struggle for control of resources. The four distinct strategies we present in this paper represent the outcome of negotiations between generations and between irrigators who have been established for some time and those that are new to the business and may engage in land and irrigation equipment rental agreements. In other words, the traditional principle of seniority that shapes social organisation and hinges on inequalities and dependencies based on kinship exists side by side with modern arrangements that build on new forms of inequality. Thus, beyond the technological adoption and diffusion, FLID involves the rebalancing of relationships and negotiations between the generations (Chayanov, 1966; van der Ploeg, 2013).

The research was conducted in five vegetable-growing areas (Kochilo, Kamariga, Obenge, Likunu and Osindo beaches) in West-Uyoma, part of Siaya County in West Kenya (see Figure 1). We purposefully selected this area for the known presence of farmers' irrigation initiatives. The beaches extend along approximately 13 km of shoreline. The average length of each beach is 1-1.5 km. Cultivation takes place on fields that are adjacent, or close to, Lake Victoria, from where the water is pumped. These plots are mostly within 200 m of, but occasionally 300-500 m from the shore. The total size of each of the horticultural production sites is approximately 10-25 ha (25-60 acres).

There are currently between 15 and 40 irrigators active at each of the five beaches that form the core of our research area. Tomatoes and a few kale varieties (e.g. *sukumawiki*) are widely grown, together with indigenous vegetables and fruits. Watermelon and capsicum have been more recently introduced.

Figure 2. Obenge Horticultural Area (Source Google Earth).



This study did not explicitly look at gender relations. In all our 27 cases men were reported to own and manage the pumps and we only interviewed men to reconstruct the history and current dynamics of irrigation. Women are certainly also involved in horticultural production and to fully understand irrigation practices it would be crucial to study the gendered nature of labour organisation and the appropriation of irrigation technology.

### THE SPREAD OF PETROL PUMPS ALONG THE SHORES OF LAKE VICTORIA

The Luo have a long tradition of combining fishing with small-scale agriculture. Fishing has traditionally been a major source of protein and income for the Luo. Over the last 20 years its importance as a livelihood has diminished due to overfishing and a decline in fish species associated with the introduction of a predator species, the Nile Perch (Medard et al., 2015; Geheb and Binns, 1997; Reynolds and Greboval, 1988). The Luo have always practised small-scale farming, but its importance over the years has increased. The fragmentation of land ownership, drought and crop failures drove people living along the shore to look for alternatives as fisheries diminished and it became harder to make a living from fishing. The idea of irrigation emerged as residents saw the potential of horticultural production for which little land is needed and which requires little technical knowledge to operate the pumps. Labour is abundantly available as many people are looking for alternative or additional employment. Those with land and money, mostly elders, began pioneering bucket, and later pump, irrigation. At first many combined vegetable production with fishing (Geheb and Binns, 1997; Cohen and Atieno Odiambho, 1989); this worked well as the latter filled the time between land preparation, weeding and harvesting.

When the first small petrol pumps, imported from India and later China, became available on the market the horticultural sector transformed rapidly and new dynamics emerged. The first petrol pumps are said to have arrived in 1995. As their numbers increased the lake region transformed from primarily a source of fish to one of fruits and vegetables. It is important to understand the speed and intensity with which various petrol pumps found their way to hardware shops in the region. Differing widely in

terms of make, country of origin, pumping capacity, durability, discharge, efficiency and maintenance requirements, pumps eventually came to play a central role in the transition from fishing to horticulture. As with motorbikes and mobile phones, the spread of the 'made in China' and 'made in India' pumps was facilitated by a service and spare-part network that resulted in the pumps being seen as a reliable and trustworthy investment. Robert, a key informant who is an engineer and owns his own workshop, explains:

The spare parts are readily available in store. For machinery, having spares is essential. When things are settled in the market for some time the people have confidence in them. The critical thing is reliability; it is important that something is known in the market, that farmers have used it before and that it can be serviced. In terms of the technology, most mechanics around here can do it as they have experience with motorbikes.

Robert gave us some chronological background.

Many farmers now use water pumps, and the number has increased since I came in 1998, when there were only two or three water pumps in this area. Right now I cannot even count how many water pumps are here, and they are springing up everywhere.

The first people involved in horticulture all indicate that they started at a small scale with manual bucket irrigation. Most vegetable growers did this for one to two years before acquiring a petrol pump. A few farmers used a treadle pump before moving on to petrol. Farmers who have started more recently began using petrol pumps as soon as they became available in the local hardware shops.

Local farmers see the upgrading (or modernisation) of equipment as a logical way to develop their horticultural operations. They often talk of bucket irrigation as heavy, tiresome and difficult. A petrol pump can irrigate a larger area with more water in less time. This allows farmers to increase the area under irrigation, while ensuring crops have sufficient water. When irrigation was predominantly manual the scale was much smaller: often about 10 x 10 m (0.025 acre). With the expanded use of pumps the scale has increased substantially; in some cases 20-fold, in others even 60-fold. Fields nowadays range in size from 0.5 to 1.5 acres. One challenge for irrigators is that too much water can stress crops. However, the advantages of irrigating outweigh this: production increases; less labour is required; the pumps are easy to operate; and the costs are manageable. The pumps can be easily moved from one production site to another, thus increasing the income from growing crops. The ideal situation for an irrigator is to own their own petrol pump, allowing them to be independent (as opposed to renting or sharing one) and to better plan their activities. Willis was establishing his own farm and renting a pump. He aims to have his own:

It would be good to have it [the pump]; it will make my work easier. I will dance with happiness when I get one. I am working hard for it. This is my dream, so I can grow more and better tomatoes.

The growing scale of vegetable production is fuelled by, and simultaneously fuelling, an expanding regional economy. The market now extends spatially and socially beyond the lakeside. More distant markets are being served, where much higher prices can be fetched and the demand is larger and more stable and secure. Horticulture on the shores of Lake Victoria is at a larger scale than ever before. As one of the vegetable growers described:

There is a new pattern of land use along the shores. You used to find that the shores were not much utilised, just for grazing cattle. Now there is no land left for grazing; it is all occupied. People try to utilise all the land, and it is continuously moving outward from the shore, and there is more competition [for land].



## DIFFERENTIAL FARMING STRATEGIES

Our engagement with the vegetable growers made it clear that, for many, developing their horticultural operations is an important factor for them and their families' wellbeing. Yet, the different roads to becoming a successful vegetable grower are, to use the local vernacular, 'paved with challenges'. Based on 27 interviews with irrigators (see Table 1) we identified four main strategies, which seem mostly differentiated by the control that irrigators have over 'the means of production' (land, labour, capital) and the timing and their mode of entry into horticulture. There were notable differences between those who had acquired land through inheritance and those who had had to purchase or rent land. Dependency on others for access to a pump versus owning one outright was significant. The timing of arrival in the sector also plays a role; late-comers may have an advantage in that they can learn from those who preceded them but also find it harder to access markets as traders prefer to buy from producers they already know and trust.

Based on the differing conditions and situations we identify four groups of producers: those seeking to consolidate their position ('consolidators'), those continuously seeking to innovate and looking for new crops and market opportunities ('innovators'), those seeking to diversify and combine vegetable growing with other businesses ('diversifiers') and those struggling to make ends meet as they face ups and downs ('strugglers'). We would stress that these are 'typical' strategies rather than strict classifications. In the patrifocal context of the Luo, the 'consolidators' represent the senior men in the family who ventured into vegetable production on the basis of secure access to land, often by selling cattle to purchase pumps and hire labour. The proceeds of vegetable production were reinvested in order to gradually increase the scale and intensity of the enterprise. Being in this position gave them a head start in terms of markets as well as ownership of pumps. Their control over land strengthens their central role in vegetable growing. The others ('innovators', 'diversifiers' and 'strugglers') have only been able to enter the horticultural sector by forming alliances and cooperating with other growers and/or land-owners in order to rent or purchase land, hire labour and purchase or hire pumps. They are further differentiated by the way that they organise their labour process, which is partly a reflection of being newcomers to the vegetable production sector (those who struggle) or being older but having accumulated capital elsewhere which is used now for vegetable production (those who diversify and innovate). Some make money by renting out pumps to other vegetable growers. The 'innovators' have a strategy of exploring niches that others are not yet operating in and continuously look out for new crops, such as watermelon and capsicum, and new production techniques. This can create new opportunities for them but also, as we will see later on, new dependencies.

### *Strategy 1: Consolidate*

Martin is a 42-year-old farmer in Osindo, who started farming in 1998. He cultivates vegetables on 2.5 acres, which he inherited from his father. His crops include tomatoes, onion, kales, coriander, watermelon and butternut squash. He also tried spinach and carrots, but there was a lack of market for them. He is currently growing watermelon on 1.5 acres. Since only a few farmers do this it is a good market.

Martin is mentioned by the hardware shopkeeper in Manyuanda as a 'mentor farmer' in the area. Mentor farmers are known for their experience and expertise, and others often come to them for advice. He hires people to work on a piece of land called a 'keo'<sup>2</sup> When we visited his farm we found him weeding together with his workers.

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<sup>2</sup> A keo is a strip of land about 2 m wide of variable length. Workers are paid per keo.

Table 1. Four different farming strategies (n=27).

| Strategy             | Keywords   | Crop diversity                            | Market                                      | Other income sources                                  | Petrol pump                            | Labour organisation                                 |
|----------------------|--|---|---|---|--|---|
| 'Consolidate' (n=4)  | Experience, stable position, safe market, financially secure, own equipment, large-scale | Mainly tomatoes                           | Urban markets, year round production        | Livestock, crops, own oxen and ploughs for hiring out | Individual ownership                   | Largely rely on hired labour                        |
| 'Innovate' (n=8)     | New market opportunities, trying new crops, high input levels, risk-taking               | New crops and tomatoes                    | Urban mainly looking for gaps in the market | Livestock   | Individual or shared ownership         | Means to hire labour, access to labour is difficult |
| 'Diversify' (n=5)    | Combine farming with non-farming-based business  | Grow crops that require less labour input | Urban and local                             | Livestock, small business                             | Individual or shared ownership or hire | Means to hire labour and access land are difficult  |
| 'Struggle on' (n=10) | Financially limited, small market, fishing money, vulnerable, small-scale                | Many crops; risk averse                   | Farm gate and local                         | Mainly fishing  | Shared ownership or hire               | Limited means and access to hire labour             |

Source: fieldwork (Bosma, 2015)

Martin looks for markets in the urban centres, travelling by motorbike or more often hiring a pick-up truck, with a driver, costing 2000 KES.<sup>3</sup> This allows him to sell produce in Bondo, Siaya or Kisumu. Other farmers also do this. With the motorbike he can only transport a small amount, but with a truck he can take 10-12 sanduku.<sup>4</sup> He avoids smaller markets, such as Kamariga and Manyunda, as there are not enough customers. He also times his tomato production so as to get the best price.

Martin owns his own petrol pump, a 6.5 hp Briggs & Stratton, which he bought in 2015 for 40,000 Kes (~US\$450). In 1998 he owned a 5.5 hp Honda and thought it was the best, but he is no longer so sure. He owns sufficient pipes<sup>5</sup> (30 in total) and oxen, which he also rents out to other farmers. He hires a tractor during the dry spell when the cows are too weak to plough and this makes tilling the land easier.

I am happy with the pump but the functioning is not ideal. It renders a lot of 'food' at once, and after that the crops 'starve'. Water is applied in excess with this system. I would like to switch to drip

<sup>3</sup> The exchange rate during the period of field research was approximately 100 Kenya Shilling (KES) to 1 US Dollar.

<sup>4</sup> Sanduka is KiSwahili for a crate holding about 64 kg.

<sup>5</sup> The lengths of the pipes vary but usually these are 3 metres long.

irrigation and get a bigger pump. I have thought of switching to a diesel pump, but these are expensive, about 200,000 KES, although they can serve more people and more land.

Consolidators are also able to time their cultivation in order to supply tomatoes during periods of high demand. Both marketing strategies result in a high price. An established farmer commented:

The market for tomatoes is best in March-April-May; these are the best times to get a high price for your product. You can get about 5500 KES [~US\$60] for one sanduku of tomatoes. In the rainy season I grow tomatoes on a small part of my land, which is close to the lake, with a good slope that allows the water to drain away very well. I sell these tomatoes for a good price.

Martin is a consolidator who has developed his farming business through a process of expansion and innovation. Four farmers in our sample could be classified as 'consolidators'. They are the oldest, ranging between 42 and 52 years old, have been farming for 10 to 30 years and own large fields (1-8 acres). They own their petrol pumps and earn good money from vegetable production. They enjoy their autonomy and not depending on others. Unlike the 'innovators' or 'diversifiers' they do not hire out their pumps. They rely only on the labour of others and are widely known in the area as hirers of labour. A combination of experience, investment capacity and scale of production enables these farmers to secure good market opportunities. They sell at urban markets and other stable markets and obtain a good price for their produce.

In general, the consolidators have gone through a process of exploring and finding new market solutions, expanding their land holdings and improving and upgrading their equipment. Their senior position in the community also contributes to their reputation as established farmers with prestige. They pioneered pump irrigation and were the first to open up this sector. They are happy with what they have achieved and see no need for further innovation. The land is available to them and they have increased production and quality standards. For them, preparing for the future means consolidating their current position.

### *Strategy 2: Innovate*

Steven is a young farmer of 27 who began farming in 2014. We interviewed him when he had his first crop in production: two acres of watermelon in Kamariga. The land belongs to an uncle, and he is fortunate to be able use it for free. He attended college, studying water technology and resource management, but after getting his diploma he decided to go into farming.

A friend of Steven's helps him with the weeding. He usually works by himself but can call on friends for help when needed. His family does not usually help on the farm. He is committed to his production and spends long hours on his field, shoeing the cattle and goats away. He owns his own pump, a 7.0 hp Huawei, but said he needed a larger pump as his land is a bit further away from the water source.

Steven is one of eight farmers who can be classified as innovators in that they are looking for new strategies in farming. They are relatively young, from 27 to 45, and have only recently started producing horticultural crops. They are serious about farming, are busy expanding their business and are looking for ways to make extra money and maximise their profit from growing vegetables. They are willing to take risks in cultivating new crops for which market demand is not secure. They aim to improve their farming businesses, although they also have jobs outside farming, such as business or keeping cattle and poultry. These other jobs are mainly considered as preparation for the future when they become 'too old' for farming.

They share the objective of looking for new and improved crops, varieties and inputs for their horticulture production. Capsicums and watermelons were mentioned as examples of newly introduced cash crops. One farmer explained why he switched to watermelons and his underlying strategy.

When I started farming I grew tomatoes, but too many people have started doing this, so there is too much supply, which is why I shifted to watermelons. Now more people are growing watermelons, so next season I want to switch again, to capsicums. I do not want to grow what the other farmers are growing. If they follow me, I will start growing a different crop again and will create my own market.

In addition to using more inputs, such as hybrid varieties, fertilisers and pesticides, to increase yields this group of farmers also try to upgrade their equipment for ploughing and irrigation in order to improve their farming business. Seven of the eight innovator farmers own their own petrol pump, and the other uses a group pump, to which he has direct access. Most bought their petrol pumps to expand their farming and increase production, as well as to better manage their own working time and plan their farming activity and strategy. Given the workload associated with a larger farm, the pump is needed to reduce time and energy for irrigation. Yet they see shortcomings with this type of irrigation, with regard to its effect on the crops and the operating cost. They would like to change to other 'modern' types of irrigation in the future. Innovators do most of the work themselves, but in busy times casual labour is hired. They prefer to hire skilled labour, but this is difficult to find, so they prioritise and outsource specific tasks. The amount of money that they can free for investment determines the size of their operation and plans to expand. Hiring labour is a key aspect of this, as one of them explained.

You have to value everything, estimate how much it costs when you let someone else work. You must know if it brings you a profit or if you might lose from it. Sometimes I have to hire someone to work, as I cannot cultivate the whole land by myself.

Innovators have managed to access land that is not controlled by the elders and hence have avoided dependency on them. Their land tends to be at a greater distance from the beaches. They differ from the 'established' farmers in being more focused on 'modern' farming and more willing to take risks, and this shows in their fields. They certainly do not want to farm in the same way that their fathers do (see also Ramisch, 2014).

### *Strategy 3: Diversify*

Cliff is a 40-year-old farmer with a field in Kochilo, where he has been farming for 12 years. He lives together with his wife and six school-going children in Kagwa, near the Makasembo school, less than 3 kilometres from his field in Kochilo.

Before going into farming he was employed but was not 'comfortable' with it. With the little he had he decided to start farming, since he had grown up in a family that grew rice and sugarcane. He had some relatives in Kochilo and saw that the area was good for agriculture because of the type of soil. The farming conditions in Kochilo are good and it was easier for him to find land there than in his home area. It is a fishing community, and Cliff thinks they do not much like farming or know how to use the land. He says that farming is not like fishing: you have to wait. When the locals see his harvest they want to copy him. Cliff sells his tomatoes at the local markets to people who have money from fishing. He and his wife also own a small shop in Kamariga centre, where they sell a wide range of products.

Cliff bought his own pump, a Tiger, which he acknowledges is not the best brand. However, it was cheap, and he just wanted something to help him, even if it would not last. He leases his land and does not want to invest in expensive materials because he does not know when the owner will want his land back. The money made from the field can also be invested in the shop and animals at home. He owns a motorbike, which he rides to Kisumu to purchase items for the shop.

Cliff's main concern is time, which he must divide between the field and the shop. He now only uses the petrol pump himself as he has no time to rent it to others and does not want others to spoil his machine. During our field visits he was often occupied in the shop, as his wife was ill, and was also having difficulties with the landowner. His latest harvest failed due to these problems and he planned to cultivate tomatoes on a different field the following season.

Cliff is one of five farmers who can be labelled as 'diversifiers' as they combine multiple jobs. They diversify because of the insecurities around access to land and markets. They alternate their farming activities with other work, such as business, fishing and keeping animals. The money earned from farming is invested in their other activities, with the idea of increasing their investment capacity over time. They range in age from 26 to 40 and cultivate relatively small fields (of 1 acre or less), which they usually lease. Four of the five diversifiers own a petrol pump, and the other is the caretaker of someone else's petrol pump. They generally use rented oxen for ploughing, although sometimes a tractor, particularly when a good till is needed and they have the money available.

Diversifiers straddle between on-farm and off-farm investments. Given their involvement in other jobs and businesses, petrol pumps help them reduce workloads and save time. In other cases, investments are made elsewhere, and the drawbacks are outweighed by income generation. Diversifiers strategise their farming business to maximise profit. Decisions are therefore based on what will generate the greatest profit in a short time.

#### *Strategy 4: Strugglers*

Willis is 49 years old and has been growing vegetables since 2011. Before then he had been engaged in what he calls 'peasant farming' for a long time. He started vegetable farming when school fees and other living costs led to a difficult financial situation. The land he uses in Obenge beach was inherited from his father. He uses a quarter-acre plot to produce tomatoes and kale and has a three quarter-acre plot uphill where he grows maize, beans and millet in the rainy season. He acknowledges that he only realises small profits, but it still helps to support his family. His first year was very difficult as he lost money, but in the second season he realised a profit of 5000 KES. In 2014 he was in his third season and was having problems with a small caterpillar pest that lowered his production and meant he was unable to pay his daughter's school fees.

Willis grows local varieties, and, although he knows that hybrids are better, he says that they are too expensive. He mainly sells at the farm gate, as people come to the field at harvest time to buy. Otherwise, he takes his produce to local markets. Willis does most of the work in the fields himself as it is generally too expensive to hire others, except when he is transplanting and needs one man to irrigate with a petrol pump. "When you hire workers they need money; if you don't have the money, you have to do it yourself" he explains. He cultivates the land by himself. When we met Willis he had spent the past week digging with a *jembe* (hand-hoe).

It was a marathon job, but I did it all myself. I take my food and drink with me to the field early in the morning and stay there the whole day and dig. I did everything myself. Next time I think I will use the oxen and plough. It really was a marathon job and I think it made me sick. It will be better to not do this by myself the next time.

Finance is a limiting factor for Willis, but he realises that it is necessary to buy the right inputs to do well in farming. Besides needing irrigation he says that "you can do well if you spray with pesticides and use fertilisers and chemicals". But these inputs come at a price, and this makes it difficult for him. His ambition for the future is to expand in farming by doing horticulture on the higher plot of land. He needs to expand to get more money, so his children can go to school. This means that he needs a powerful enough pump – of at least 6.5 hp – to bring the water to this field. He wants a Honda, Koshin or Dashin, which would cost him about 55,000 KES (~US\$610). These are good machines according to Willis, but they are expensive and this is a problem for him.

Willis is in the group of 'strugglers', consisting of ten horticulturalists. They are generally younger than the vegetable growers in the other categories: at least five are under 25; of the others Willis is the oldest at 49. The challenges faced by the strugglers are their financial limitations, the difficulties in accessing land, due to the high demand for land, and accessing markets. They are risk-averse and

struggle to cope with their challenges and limitations. They have relatively small businesses – generally 0.25-0.5 acres. Their production is not enough to sustain their families so they need other sources of income. Most also fish and invest the proceeds into their horticultural activities.

I also sometimes do some fishing as a substitute when I need money. The problem is to get enough capital for farming, as you need inputs to sustain your farming. If you do not have enough capital, you cannot pay for the water, the fertilisers, spraying, seeds, etc. Then your plants will not do well.

'Strugglers' work in partnerships and groups to find ways to access land and other resources, sharing their investment costs, particularly those for land, equipment and labour. Pooling their labour helps them manage the workload and reduces the need to hire labour. They also often rely on friends and family for labour. They try to invest in modern inputs in order to increase their yields, but mostly they rely on local varieties when there is insufficient money to buy hybrids. Buying the necessary equipment is a challenge for the strugglers. They all try to hire or borrow ox ploughs and petrol pumps, but this places them in a position of dependency, limits their activities and differentiates them from the 'established' farmers. They all aim to get their own pumps.

## CONCLUSIONS

Our analysis of the use and spread of petrol pumps along the edges of Lake Victoria shows rather organic and non-linear process, in which policy actors, such as the state and NGOs, have been surprisingly absent. The pumps satisfy a genuine demand for time- and labour-saving technologies and have spurred an intensification of an existing, albeit small, sector of commoditised horticultural production. Local merchants began the process by buying pumps to sell, but the irrigators emerged as the key actors, incorporating the pumps into their labour process. Our analysis emphasises the culturally embedded and generational dimensions of a process of technological appropriation and adaptation lying at the centre of a much broader process of agrarian change. The introduction of petrol pumps as artefacts of modernity combined with labour migration, education and the further expansion of the regional commodity economy offered ample opportunities for livelihood diversification.

We have shown that irrigators clearly collaborate with each other in their efforts to make modernity work for them. This pertained to acquiring access to the pumps (and other inputs) and is not restricted to those sharing the same strategy. There is some evidence that consolidated success leads to changes in strategy, but these are not unilinear, as farmers are differentially embedded in extended networks of relations of dependency. Many vegetable growers indicated that they had gone through, or were in the process of, a transition from small-scale and low-input farming to larger scale farming using modern inputs and better equipment with the aim of achieving higher outputs. This required the continual negotiation of access to resources, especially land, labour and money. It is questionable, however, whether those who have adopted the strategy of innovation will transform their practices and strategies so that they resemble those of the 'consolidators'. Those who struggle and innovate aspire to occupy the same position as the 'consolidators' but lack the abundant access to land and/or capital that is enjoyed by the elders. What 'strugglers' and 'innovators' have in common are strong values of individuality and independence. They aim to own their land, resources and equipment because individual ownership enables them to dictate their planning, budget, timing and work. Petrol pumps allowed vegetable producers to expand their farming operations independently of the elders. Nonetheless, they are being challenged by the elders, who, given their control of capital, land and labour, remain among the main beneficiaries of petrol pump use.

The spread and use of petrol pumps as a prime example of FLID clearly shows that FLID is not a neutral process of making modernity work for all the social actors involved. The pumps evidently opened socially differentiated spaces for profit-making horticulture for the elders as well as those operating outside their historic control. Our case underlines that modernity is not to be understood as

the product of technological interventions but as constantly constituted and refashioned in their interaction with diverse modes of organisation, rationalities and markets. Thus the appropriation and use of petrol pumps in West-Uyoma represents more than the supply and demand of irrigation technologies. Farmers have seen the benefits of petrol pumps, and chose to use different types in different circumstances (physical and economic), seeking to adjust and fine-tune them to fit their socio-economic conditions as well as their aspirations. The 'plasticity' of the pumps means that they can be adapted to maximise their usefulness in developing a farming business. The research identified significantly different strategies, which shows that farmer-led irrigation development does not follow a single, homogeneous trajectory that can be planned in advance (with or without external assistance from development agencies). The rationales involved also vary as they are closely associated with the ownership of assets, the willingness to take risks and relationships of dependency. The paper shows that while the technology of petrol pumps is uniform in its function of lifting water, the irrigators themselves give this technology meaning and make it perform by accessing, using and adjusting it in alignment with their strategies, constraints and aspirations.

### ACKNOWLEDGEMENTS

The publication of this paper in an open access journal has been supported by funding from the DFID-ESRC Growth Research Programme through award ES/L01239/1 "Assessing the growth potential of farmer-led irrigation development in sub-Saharan Africa".

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