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The impact of irrigation on small-scale African indigenous vegetable growers' market access in peri-urban Kenya

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ABSTRACT

Small-scale private irrigation is widely advocated as a means of improving agricultural incomes in Sub-Saharan Africa. Using the case of smallholder producers of African Indigenous Vegetables (AIVs) in peri-urban Kenya, we study whether irrigation-driven productivity growth translates into improved market participation by smallholders. We therefore a) identify factors that drive smallholders to adopt irrigation in Kiambu and b) study how irrigation affects vegetable marketing. We combine a regression analysis and propensity score matching in order to advance existing knowledge on the linkages of irrigation and marketing. We use a 2014 survey of 176 AIV producers in Kiambu County and 156 AIV traders in Nairobi County. We find that irrigation corresponds with up to 99% market participation rate and 86% of output sales. We find that irrigators participate more in urban markets, compete effectively with market intermediaries, have more price bargaining power, sell less at farm gate and face shorter value chains. Surprisingly supermarket outlets were associated with non-irrigators, while irrigators opt for wet markets. Although irrigators have larger commercialization indices, the effect of irrigation depends on the type of technology used. We find that irrigation and the associated access to better marketing arrangements is skewed towards farmers with off-farm income and male headed households. Targeted support for female-headed agricultural households to access modern irrigation technology is therefore an important policy measure we propose.

1. Introduction

Smallholder farms, averaging less than three hectares, occupy 60% of cultivated land, account for 75% of total agricultural output and 70% of marketed produce in Kenya (Olwande et al., 2015; GoK, 2010; Salami et al., 2010; Minot and Ngigi, 2004). With agriculture accounting for up to 24% of GDP, smallholder farms effectively determine the performance of the Kenyan economy (AGRA, 2013; Ogada et al., 2010; de Janvry and Sadoulet, 2010). For several decades, however, this performance has remained dismal, reducing prospects of smallholders driving growth and development.

An array of production and marketing challenges, unique to smallholders, limits their contribution to economic development (Fischer and Qaim, 2012; O'Cass and Viet Ngo, 2012; Alene et al., 2008). For smallholder farming to drive the development agenda in the region, a widespread transformation of these farms from semi-subsistence, low-input, low-productivity units to intensive, market-oriented units is needed (Olwande et al., 2015; Fischer and Qaim, 2012).

Two components of this transformation are critically important: smallholder productivity growth (Alene et al., 2008; Barrett, 2008; WDR, 2008) and improved access to markets (Chamberlin and Jayne, 2013; Fischer and Qaim, 2012; Obi, 2010). Productivity growth requires development, dissemination and adoption of yield-increasing technologies. In return, productivity-enhancing technologies facilitate attainment of marketable surpluses, which then contribute to household income and improved livelihoods. Barret (2008) refers to this approach as the "agricultural productivity pathway" out of poverty and subsistence agriculture. Unfortunately, productivity growth alone is insufficient to address the numerous challenges faced by smallholders when marketing their produce (Minot, 2011; Jagwe et al., 2010; Obi, 2010). These farmers usually face weak or non-existing markets due to failed coordination and high transaction costs (Obi, 2010). Under these market conditions, high productivity provides only marketable surpluses but may not translate into significant economic benefits for farmers' because of inexperience in marketing high-value commodities (Minot, 2011).

Inaccessible markets, resulting from socioeconomic, institutional and infrastructural conditions faced by producers, is considered more

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limiting to smallholder farming than low productivity (Alene et al., 2008; Pingali et al., 2005). Often, poor infrastructure and poor access to supporting services expose farmers to high transaction costs, which in turn reduce incentives for market participation (O'Cass and Viet Ngo, 2012; Fischer and Qaim, 2012; Alene et al., 2008; Barrett, 2008; Key et al., 2000; Omamo, 1998). Equally, limited livelihood means restrict farmers' access to resources and services needed to upgrade their farms to market-based production standards (Fischer and Qaim, 2012; Wiggins et al., 2010; Reardon et al., 2009). Smallholders are also excluded from emerging markets due to enforcement of quality standards and modernization of procurement systems (Olwande et al., 2015; Okello et al., 2008). These challenges, combined with seasonal cash shortages, lack of produce handling facilities and little market information, further weaken farmers' position along the value chain (Pokhrel and Gopal, 2007). Given this reality of markets in SSA, researchers have recommended that addressing smallholder productivity growth be coupled with measures to enhance market access (Fischer and Qaim, 2012; Alene et al., 2008).

Recent studies (Venot, 2016; Domènech, 2015; Wichelns, 2014; Burney and Naylor, 2012; Dillon, 2011; Hanjra et al., 2009a,b; Connor et al., 2008; Huang et al., 2006) have unanimously identified irrigation as the main productivity pathway out of poverty and subsistence farming in SSA. Irrigation is regarded as the vital and missing component for transforming smallholder farms from subsistence to market-based, commercial production standards (Mutabazi et al., 2013; Burney and Naylor, 2012; Jaleta et al., 2009; Herbert et al., 2002; Sally and Abernethy, 2002). The argument is first, that irrigation leads farmers to adopt high-value crops and deliver better-quality produce (Burney and Naylor, 2012). Second, irrigation facilitates intensification of smallholder production systems and adoption of other productivity-enhancing inputs. Third, irrigation makes smallholder farming more resilient to climate shocks and allows production planning to respond to the prevailing market conditions. This way, irrigation leads to productivity growth, employment due to demand for farm labour, improved livelihoods, and improved food security.

Until now there are, however, no studies on the relationship between smallholder irrigation, market participation and improved rural livelihoods. Using the case of smallholder vegetable producers in peri-urban Kenya, we seek to identify whether irrigation-driven productivity growth translates into improved marketing conditions for smallholders. Our study aims to answer two questions:

- Which factors drive smallholders to adopt irrigation in Kiambu?
- How does irrigation impact vegetable market participation and marketing arrangements of smallholders?

Understanding this relationship is critical, given that market participation is the largest constraint facing smallholder farming in SSA. Particularly in Kenya, 84% of the country's total land mass is either arid or semi-arid land (ASAL) and unsuitable for rain-fed crop production (GoK, 2009). Second, only 4% of cultivated land is irrigated and third, the distribution of available surface water in Kenya is strongly skewed (GoK, 2009). Promoting irrigation agriculture as a pro-poor strategy in Kenya therefore requires immense investments. Understanding fully how irrigation, as a path to improved livelihoods, is related to the main challenge facing smallholder farmers in the country is critical.

The rest of the paper is structured as follows: In section two we describe the data sources used for the study. Section three is a description of the empirical approach used to evaluate impacts of irrigation development on smallholder market participation. In the section that follows, we present key findings on the nature of smallholder AIV irrigation and the relation of irrigation and marketing arrangements. This is followed by an in-depth discussion of these results in section five. In section six we present our conclusions and recommendations for further research on the topical issue of irrigation as a strategy for smallholder agriculture development.

2. Material and methods

2.1. Survey data

This study used data sets for 176 African indigenous vegetable (AIV) producers in Kiambu County and 156 AIV traders in Nairobi County. Data used in this study were collected as part of the project "Horticultural Innovations for Improved Nutrition and Learning in East and central Africa" (HORTINLEA) in Kenya (HORTINLEA, 2014). This study used baseline household survey data collected in 2014. The multidisciplinary research project HORTINLEA focused on investigating the socioeconomic, institutional, environmental, nutritional, and health dimensions of AIV production, consumption and trade in rural, peri-urban and urban areas.

The study area is a peri-urban county bordering Nairobi and Kajiado Counties to the South, Machakos County to the East, Murang'a County to the North and North East, Nyandarua County to the North West, and Nakuru County to the west (GoK, 2016). Kiambu County covers a land area of about 2543.5 km^2, is divided into ten sub-counties and is home to an estimated two million people. Of the county's total land mass 1878 km^2 is under cultivation, 649.7 km^2 is not arable land, while 15.5 km^2 is covered with water bodies.

The average farm size in the county is approximately 0.88 acres in the smallholder regions and 169.5 acres in the large-scale regions, where coffee, tea, and pineapples are the main crops. The smallholder farms are commonly found in the upper parts of the county, where this study was undertaken. In this region, food crops and dairy farming are the main agricultural activities. It is estimated that 85% of land owners have title deeds and the remaining 15% do not, owing to unfinished land adjudication processes and non-payment of necessary charges. Like elsewhere in Kenya, agriculture is the main source of livelihood in the county. Vegetable growing is the main agricultural activity in the study area (Rao et al., 2012) (Fig. 1).

The close proximity of Kiambu county to Nairobi provides producers with a ready market for vegetables all year round (Rao et al., 2012; Ngugi et al., 2007). Similarly, the small land sizes in Kiambu give preference to horticultural production, because of its relatively high price and return on land and labour (Olwande et al., 2015). It is estimated that 69% of cultivated land in the county is allocated to vegetable production (Rao et al., 2012). In addition to the five AIVs in this study, the other leafy vegetables important to farmers are spinach, kales, and cabbages (Rao et al., 2012). AIVs have gained particular importance in the recent past in response to higher demand around the city due to increased consumer awareness of their health and nutritional benefits (Ngugi et al., 2007).

2.2. Method for evaluation of impacts of smallholder irrigation on horticultural marketing

Differences in costs faced by farmers in the marketplace can explain why some participate in agricultural markets, while others produce only for own consumption. Similarly, unequal access to assets and services to mitigate these costs can explain the heterogeneous market participation among smallholders (Alene et al., 2008). Generally, smallholders face higher external transaction costs, because their farms are too small for economies of scale to be realized. Hence, they have higher unit costs for inputs and outputs market participation (Wiggins et al., 2010). To overcome marketing challenges presented by high transaction costs, farmers adopt various measures to boost their productive capacity, attain sufficient marketable quantities, and facilitate market participation. Technological innovations, such as building irrigation, are one way farmers can achieve economies of scale, participate in markets and improve livelihoods.

To reap the benefits associated with irrigation agriculture, like any other technology, farmers have to decide independently whether or not to invest in irrigation. Additionally farmers will have to choose from