11

Ricing Fortunes

Agricultural Growth, Farm Intensification, and Paddy Specialization in Two Tanzanian Villages

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Epilogue pages 414–417

Introduction

Smallholder-based rice-led agricultural growth through farm intensification and paddy specialization is a development path that has commonly been associated with the South East Asian Green Revolution experience of the 1970s (Hayami and Ruttan 1985). In sub-Saharan Africa, only Madagascar and West Africa have been traditional paddy-producing areas, but over recent decades, rice has gained increasing popularity throughout the region and is gradually taking over from alternative grain staples such as maize and millet. With growing consumer demand, new income earning opportunities are opening up for domestic paddy producers (Balasubramanian et al. 2007). With both rice consumption and paddy production increasing substantially, Tanzania provides an example of this relatively recent trend and the country is now the fourth largest rice producer in Africa, in terms of tons harvested (FAOSTAT 2018).

In this chapter, we provide an in-depth study of two villages in Kilombero District in south-central Tanzania, one of the rice baskets of Tanzania. Here, agricultural growth and farm-intensification dynamics are based on the expansion of the production of paddy rice over the past decade and a half. Relying on a mixed-methods approach we show that over the time period from 2002 to the present, smallholder farmers have significantly increased the area under paddy, total rice production, and land productivity. Similar to the South East Asian examples, the intensification dynamics in the two villages are based on a combination of technological change through new rice varieties and farm in-puts as well as mechanization, and improved producer incentives transmitted through expanding markets. Experience suggests that the possibilities for enhancing agricultural productivity

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in an African smallholder context are not quite as bleak as is sometimes assumed (see e.g. Collier and Dercon 2014).

Meanwhile, the two villages offer a couple of unique twists to this conventional pattern of technology and market-induced intensification, related to the development of the broader Tanzanian spatial economy and the evolution of gender-based land control patterns. The traditional theoretical literature on intensification pathways has commonly focused on agrarian transformation and linkages to the non-farm economy. Such perspectives posit an evolutionary path away from agrarian livelihoods in rural areas to non-farm occupations among an increasingly urbanized population (see Timmer 2009). However, in Tanzania as well as in other sub-Saharan countries, we currently see the unfolding of a multifaceted rural development path wherein different economic activities, e.g. agriculture and services, mix in the same locations. Further, we need to add an analysis of the gendered patterns of this transition as these aspects have commonly been omitted in models that seek to explain structural transformation as a gradual macro-level movement of economic activities and people from the rural to the urban, initiated by an intensification in staple crop production.

Our aims in the following are therefore several. At an overarching level we demonstrate and quantify the increases in agricultural productivity in paddy production specifically and link these to changes in technology as well as commercial incentives to illustrate the potential for a rice-based intensification process in a Tanzanian context. Moreover, we elucidate the features of this process in the two villages in question qualitatively to reflect on the pre-conditions and broader context for intensification provided by shifts in rural-urban economic opportunities and gender-based changes in access to land. A final, theoretical aim therefore is to further the understanding of rural transformation, and intensification processes, from the vantage point of these dynamics. Here we link to recent bodies of literature that acknowledge rural-urban linkages in a more general sense and normatively point to the importance of gender inclusivity in reducing poverty and enhancing growth, but do not offer either as explanations of rural transformation dynamics.

The following section contains a description of the trends of rice production in the larger Tanzanian context. It is followed by a theoretical framework and thereafter the methodology, data sources, and sites are described. The analysis of the data is presented in four theoretically motivated themes, before we conclude.

Rice-Led Agricultural Growth in Tanzania

Arab traders first introduced rice to the coastal areas of Tanzania and during the nineteenth century the crop spread along the caravan routes to the inland. It was

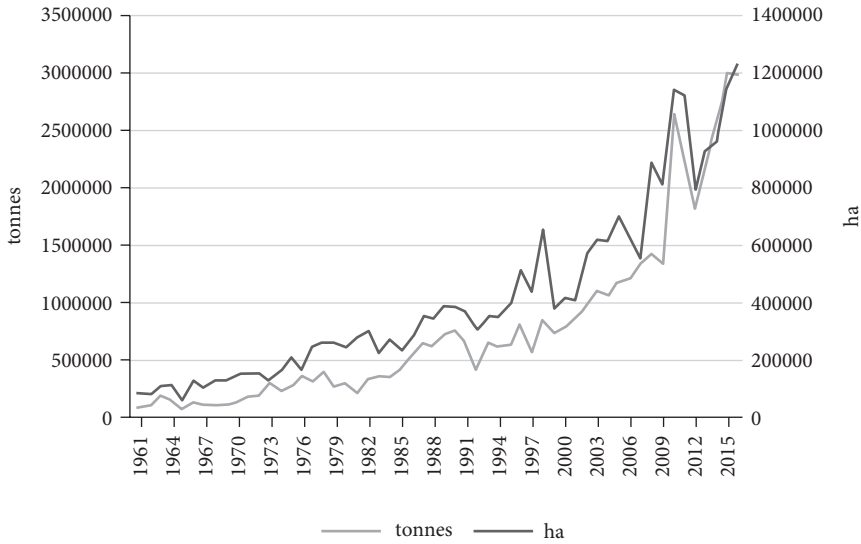

Figure 11.1 Rice paddy—production (tonnes) and area (ha) in Tanzania, 1961–2016.

considered more productive although less reliable compared to millet and sorghum, and from the 1960s it grew in importance as a subsistence staple crop (Iliffe 1979: ch. 3). Production did not, however, really take off until after Structural Adjustment Programmes were introduced in the mid-1980s (see Figure 11.1). Following the policies of economic liberalization the depreciation of the exchange rate made imported rice more expensive and opened up trade in domestic production. Rice went from being a subsistence crop to becoming a food cash crop characterized by increasing commercialization. From 1985 to the turn of the millennium it was the fastest growing food crop in the country with an annual production increase of almost 11 per cent making it the second most important food and commercial crop after maize (Amani 2006: 8). An indication of the importance the Tanzanian government attaches to the rice sector was the launching of the National Rice Development Strategy in 2008. The vision was to transform the existing sector, thought to be focused too much on 'subsistence' production, into something deemed more commercially orientated. The production target was set at a doubling of rice production by 2018 (RLDC 2009: 23), a goal that appears to have been reached already in 2016 (see Figure 11.1).

Initially rice was primarily consumed in rice producing areas and urban centres, but with changing consumption patterns and increasing incomes, demand has spread throughout the country (Amani 2006: 8, RLDC 2009). Market expansion has led to additional land being put under rice cultivation and increasing commercial specialization amongst producers.

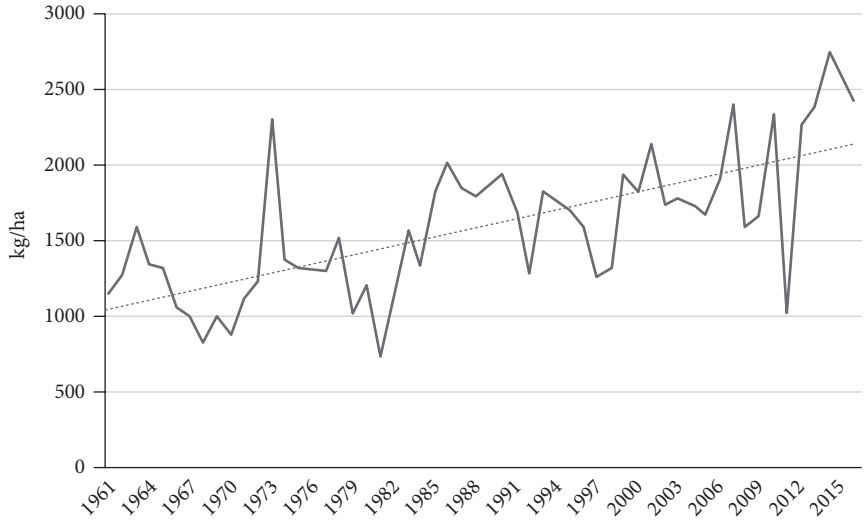

Figure 11.2 Land productivity in rice cultivation (kg/ha) in Tanzania, 1961–2016.

This is a fast-moving sector with substantial increases in both large-scale farms controlled by overseas investors (see e.g. Sulle 2017), commercial Tanzanian farmers (see e.g. Greco 2015), and a growing number of smallholders. The latter likely constituting the vast majority of rice producers. Some reports suggest that around 70 per cent of all rice grown in Tanzania is produced relying on rain-fed farming systems, while 30 per cent takes place within small village-level traditional irrigation systems (RLDC 2009: 6). Census data suggest that between 3 per cent of farmers growing rice in the Living Standards Measurement Survey of 2012/13 used irrigation, and 6 per cent of rice farmed in the 2007/8 agricultural census was irrigated (Woodhouse et al. 2017). However, using new radar data Bowers et al. (2018) suggest that FAO data on irrigation activity in rice growing areas in central Tanzania may be underestimated by up to two orders of magnitude. This shows that data on informal and unrecognized irrigation is unreliable and that accurate figures are difficult to obtain.

Women participate in all aspects of the rice value chain, particularly planting, weeding, harvesting, and threshing although to a lesser degree in trading which is traditionally considered to be men's domain in many Tanzanian societies. Nevertheless, since men in Tanzania generally have better opportunities for accessing and controlling key inputs such as land, water, credit, and technology, they are commonly understood to constitute the core group of producers (RLDC 2009: 13).

As we can see in Figure 11.2 the expansion of the rice sector is not only taking place in terms of increasing production and area under cultivation, but yields have also improved, although fluctuations have been significant. Explanations for

improvements in land productivity lie in technological change, e.g. mechanization, irrigation, improved crop varieties, and fertilizers, as well as better farming methods introduced by extension services.

Rice cultivation is particularly successful in the Central Corridor consisting of Tabora, Shinyanga, and Morogoro Regions. Half of all land under rice cultivation is found here (RLDC 2009: 6). Rice paddy cultivation in Kilombero Valley in Morogoro Region goes back to the mid-nineteenth century. Initially, it was centred along the Kilombero River, depended on run-off water, and was primarily farmed for subsistence purposes. Since the turn of the millennium, however, technological change in the form of the introduction of new machinery has made it possible to expand the areas under cultivation and increase production. Agricultural growth has been further encouraged by market expansion and rice has been turned into an increasingly commercialized crop (Kato 2007).

Farmers either sell their produce as paddy or take it to the local mill to be hulled and sold as rice. The buyers are usually local agents and prices fluctuate depending on season, location and market channels. Milling, i.e. the de-stoning, husking, polishing, and grading involved in turning paddy into rice, is growing as a processing industry in the rice-producing areas. The industry is largely dominated by small and medium scale enterprises (RLDC 2009: 14–15).

Theoretical Perspectives on Agricultural Transformation

Agricultural transformation contains a great variety of different development pathways. To understand their specifics and to typologize and draw generalizing conclusions about their mechanisms and drivers, we look inside the processes themselves and conduct in-depth investigations at the micro level (Timmer 2009). In the present study we examine two villages that could be potential examples of an ongoing national trend of rice-led agricultural growth characterized by increasing production, expansion of land area under rice production, and land productivity improvements. The process appears to contain both extensive and intensive growth at the same time.

The Green Revolution in South East Asia in the 1970s was a classic case where high population density drove a process of rice-led agricultural intensification primarily based on the use of abundant labour resources, the introduction of biological technological change, and subsequent improvements in land productivity. Meanwhile, sub-Saharan Africa has been characterized by land abundance and labour scarcity; agricultural growth has primarily taken place in the form of extensive growth (Austin 2008). The exception has been pockets of so called 'islands of intensification', which to a higher degree have resembled Asian land-labour ratios (Widgren and Sutton 2004, Hillbom 2014). With population increase and changing land-labour ratios in sub-Saharan Africa generally, the

land frontier has been reached, or is about to be reached in a growing number of regions (Djurfeldt et al. 2005). This transition phase means that the old gap between the typically Asian and African agricultural growth experiences is slowly eroding.

The classic theory for understanding how land-labour ratios shape and drive agricultural growth is found in the induced innovation literature represented by Binswanger, Hayami, Ruttan, and others (see e.g. Binswanger and Ruttan 1978, Ruttan and Hayami 1984, Hayami and Ruttan 1985). The fundamental hypothesis is that change in factor endowments, particularly the relative price of land and/or labour, determines the way that farmers participate in processes of technological and institutional change. The assumption is that actors within a system of production use technology to substitute the scarce production factor. When the scarce factor is labour, mechanization is a rational technological solution to raise labour productivity. When it is land, technological change aims to increase land productivity through e.g. irrigation, bio-chemical technology, and introduction of high-value crops. The primary empirical dichotomy used to illustrate the theory is land-abundant USA and labour-abundant Japan (Hayami and Ruttan 1985).

The development of the rice sector in Tanzania appears not to lend itself to either one of these two extremes, but rather consists of a mix of them. The area under rice cultivation is expanding and increasing mechanization plays an important role as an enabler. Commonly capital has been the truly scarce factor of production for African smallholders, a circumstance that has prevented the large majority from investing in machinery. The rising profitability of rice farming, however, allows for increasing use of tractors and other machinery leading to extensive growth and improving labour productivity.[1] Meanwhile, improving yields are partly explained by access to new machinery, but also to biological innovation in the form of e.g. fertilizer schemes and access to new crop varieties.

Notwithstanding the induced innovation theory's focus on technological change, it recognizes that the use of technology is conditioned by institutions and that the two are intertwined (Ruttan 1978). While the Tanzanian state has set up national rice strategies, its farm in-put subsidy programs and local extension services have more direct effects on smallholders' production (Msuya, Isinika, and Dzanku 2018).

Despite significant increase in domestic rice production, Tanzania is far from being self-sufficient (FAOSTAT 2018). Consequently there is scope for further marketable surplus production, commercialization, and specialization. Matching demand with supply requires well-functioning markets providing incentives for further productivity increase and technological change. In sub-Saharan Africa,

[1] This can be illustrated by the work of Woodhouse and others who surveyed hundreds of irrigating farmers in Tanzania in 2017. They found that power tillers were increasingly reported by respondents as a means of land preparation (Woodhouse pers. comm.).

market expansion and the integration of smallholders have encountered numerous difficulties and hindrances, particularly high transaction costs due to e.g. poor information and inadequate market infrastructure. Such market failure in turn cements low agricultural productivity (Barrett 2008, Shiferaw et al. 2008). However, there are also studies showing that African smallholders, given the right incentives and resources, will commercialize and deliver surplus production for agricultural markets (see e.g. World Bank 2007, Hillbom 2012).

Increased knowledge and better understanding of development challenges adds new perspectives to the existing theoretical discussion. While the induced innovations theory with its concern for bottom-up change and local stakeholders address the issues of inclusion in agricultural growth processes, it lacks a gender perspective. In rural Africa, men access and control agricultural resources to a substantially higher degree than women. What explains the unequal formal control is debated, if there are generalizable gender gaps that regularly favour men over women (FAO 2011, Quisumbing and Pandolfelli 2010), or if such outcomes rather depend on the local context (Andersson Djurfeldt et al. 2013). Notwithstanding, studies have proposed that improved female control over agricultural resources would be positively related to both securing agricultural livelihoods and initiating broad-based pro-poor growth (FAO 2011). Enhancing women's control over agricultural resources is associated with efficiency gains such as greater possibilities for securing credit and access to technologies that require capital (Agarwal 2003), managing shocks such as natural disasters or economic crises (Duflo and Udry 2004), and enabling households to surface from poverty traps (Doss 2006).

Finally, in induced innovation theory, processes of farm intensification are understood to be endogenous rather than exogenous to the economic system and each region's pathway is different as it is dependent on local factor endowments. This does not mean that we hypothesize that these systems are isolated or without exogenous influx (Binswanger 1978). In the broader transformation process urban areas have for instance been important as nodes of knowledge transfer and providers of input- and output markets to raise agricultural productivity (See Hazell, Haggblade, and Reardon 2007). Recently, a growing literature on rural transformation at a general level recognizes the importance of rural-urban linkages to agricultural growth, but the shifts in economic opportunities between the two sectors and its effects on capital flows and technology transfers has not been recognized.

A better understanding of the interplay between local-level factor endowments, institutional dynamics, and broader commercial opportunities both within and outside agriculture contextualizes the process of structural transformation in our case study. We will now move on to see how these factors—changing land-labour ratios, mechanization, biological innovation, state-led skill training, market expansion, and changing gender roles—play out in the two case villages.

To what extent have these factors been influencing trends in rice production over the years 2002–17? Can changing gender relations—especially related to control over land explain intensification patterns? How do endogenous and exogenous forces intersect and explain the nature of intensification processes in the two villages?

Data Sources, Site Selection, and Description

The point of departure for this study is a quantitative dataset—the Afrint database, which has been collected in fifty-six villages in six African countries in three rounds since 2002. Site selection for the qualitative fieldwork that constitutes the qualitative segment of the data, was carried out on the basis of trends identified in the quantitative dataset. The analysis draws on both sources of data, however.

Quantitative Data

The larger Afrint database contains data from six countries, Ghana, Kenya, Malawi, Mozambique, Tanzania, and Zambia, collected in fifty-six villages in fifteen regions. Data were collected in three rounds, 2002, 2008, and finally in 2013 (Ghana, Kenya, Malawi, and Zambia) and 2015 (Tanzania and Mozambique). The cross-sectional data cover 2544 households for the final round of data collected, and the full panel for the period as a whole (rounds I to III) comprises of 1566 households. Our focus in this chapter is the final data collection round 2008 to 2015, since the data suggest that entry into paddy production has occurred rapidly in the past decade.

The research design was based on multiple stage purposive sampling, with the original aim being to select countries, regions, and villages that held the potential for agricultural intensification at the start of the project (see Djurfeldt, Holmén, et al. 2005 for a discussion of the original principles for site selection). Within the broad context of this criterion, one dynamic and one less dynamic region was purposively selected in each country. In the case of Tanzania, Morogoro and Iringa Regions were selected, with Morogoro being the more dynamic region. Households within the villages were sampled on the basis of a random stratified sample, with the data being statistically representative at the village level. A balanced panel design has been used to maintain the representativeness of the dataset between the rounds of data collection, making up for attrition and changes in village populations by sampling additional respondents.

The focus of the project, and thus the contents of the survey, have shifted somewhat since the first phase of the project. The first round of data collection

focused on production and technology related to the major grain staples (maize, rice, sorghum) and cassava, the second round added more detailed information on commercialization and also for the first time included cash income data. Finally, the third round captured some intra-household aspects of income generation not covered in the first two rounds. While one general challenge in capturing change over time relates to the addition of variables along the way, in the case of production dynamics related to rice specifically, longitudinal data is available throughout the project cycle. Interviews were carried out with the farm manager.

A couple of general caveats relates to the survey methodology used: interviewing the farm manager is problematic for a couple of reasons—on the one hand it presumes perfect information on the part of the respondent and on the other (especially important from a gender perspective) this approach may hide intra-household inequalities related to food security and income distribution for instance. The survey samples at the village level, are small and it is therefore not generally possible to compare the data for male- and female-managed households at the village level since the limited sample size raises the risk for type 2 errors (false negatives). The chapter uses the village data from the two villages for the years 2008 and 2015, predominantly using data for the rice farmers covered by the dataset. The total number of rice farmers in 2008, was thirty-six for Idete and forty-three for Katurukila. For 2015, the number of rice producers was thirty-six for Idete and forty-one for Katurukila. While the dataset can tell us something about production trends and technology use, it cannot therefore provide sufficient explanations for these changes. For this purpose we need qualitative data.

Site Selection

As mentioned above, the two study villages were selected based on trends in the quantitative dataset. This is described in more detail in another publication (Andersson Djurfeldt 2017), but briefly, site selection was based on an interest in understanding and unravelling the gender-based patterns of what in the literature is described as 'pro-poor agricultural growth'—that is an inclusive, commercially driven process of agricultural expansion. In the dataset as a whole eighteen villages were selected, where household livelihoods had improved on the basis of increased agricultural commercialization between the last two rounds of data collection (short-term growth) or between the first and the last (long-term growth). Five of these villages were found in Tanzania, with three selected for qualitative fieldwork, Idete and Katurukila in Morogoro (Kilombero District) and Kitelewasi in Iringa District. During the course of fieldwork it became clear that Kitelewasi was a case of urbanization gradually enfolding a rural hinterland rather than an example of dynamic agricultural growth. The chapter therefore focuses on Idete—a village whose growth has occurred between the second and third round

of data collection, and Katurukila, a village that has seen an uninterrupted growth trend since 2002.

Qualitative Data Collection

Qualitative data were collected between 17 and 27 of November 2017 by a team of researchers consisting of the three authors of this chapter and five research assistants who were trained in a workshop before the start of data collection. The research assistants did separate interviews with both spouses in twenty-five households in each village to gain an understanding of intra-household dynamics related to control and decision-making in agriculture and income generation. In addition, women heading their own households were sampled and interviewed. Households were selected among the surveyed households and stratified by income per adult equivalent.

A set of key informant interviews and focus group discussions were also carried out in the villages. The purpose of these were to gain an understanding of the broader dynamics of change that had occurred since data collection in 2015 and to elucidate the reasons behind the trends in the quantitative data. These interviews were carried out by the authors. For the qualitative analysis, this chapter focuses strongly on the data from the key informant interviews and focus group discussions.

Site Description

Idete village is located about 21km from Ifakara town and is one of the four villages in Idete ward. It is serviced by public transport and thus easily accessible. The population is estimated to 2,802 individuals staying in 682 households. The main grown crop is paddy, which is used as both a cash and a food crop. The main rice varieties are local varieties (Zambia, Super India, Kalimata, Mbawa mbili) although there is an increase of farmers opting for the hybrid variety SARO. Maize, bananas, sweet potatoes, and some vegetables are also grown for subsistence. Chickens are the most popular livestock. Teak-tree farming is starting to gain popularity among villagers although it is an activity mostly pursued by outsiders (i.e. people not living in the village). Kilombero Valley Teak Company is the biggest buyer and supporter of teak-tree farming.

Katurukila village has an estimated population of 2,786 individuals and is found between Kilombero town and Ifakara town in Mkula ward. It is located 60km from Ifakara town and does not have regular public transport. Villagers relies on motorbikes (known as bodaboda) for transport to the Kilombero-Ifakara main road. Agriculture is the main economic activity. Being close to

Kilombero Sugar Company means that farmers in the village participate in the out-grower contract farming scheme, growing sugarcane (cf. Sulle 2017, West and Haug 2017). Sugarcane is however available as an option only for a minority of farmers as the initial capital requirements are high. Rice is cultivated by nearly all households in the village and is the main food and cash crop. Due to the surrounding sugarcane plantations, available land area for farm expansion is limited.

Like most of Kilombero area Idete and Katurukila have a tropical climate with bi-annual rainy seasons. The short rainy season falls between December and March and the long rains (known as Masika) fall between April and June. In total, the area receives an annual rainfall ranging from 1,200mm to 1,400mm. Most farmers primarily rely on rain, but in Katurukila there are also small-scale, farmer constructed, water-control devices for irrigation.

The dominant marketing systems in the two villages is an open free market for agriculture and livestock whereby prices are determined by supply and demand. Farmers in the two villages have access both to the internal market and the export market. Harvested paddy is either stored at home or at warehouses adjacent to nearby milling machines, at a cost. In addition, farmers in Katurukila have an option of selling paddy through the warehouse receipt system. This system increases farmers bargaining power and thus the price they receive.

Empirical Analysis

Production and Land Use for Paddy

As a first observation, we note that the trends of both extensive (increasing area under production) and intensive (improved yields) agricultural growth found at the national and regional levels are mirrored in the development of rice paddy cultivation in the two villages, as such data from the study sites confirm broader national trends. In some respect they also show the potential of yield improvements through a classical grain-intensification-based trajectory also in the case of sub-Saharan Africa.

All households except one grew rice in 2008, by 2015, all households except three (two in Idete and one in Katurukila) grew rice. The importance of rice as a driver of intensification dynamics is confirmed by the quantitative data, but there are differences between the two villages. First, while in Idete the mean cultivated area under rice has increased by 70 per cent, in Katurukila the area under paddy remained unchanged (see Table 11.1). Second, production volumes also increased dramatically in Idete. The change in Katurukila is more modest (see Table 11.2), but still sizeable in relative terms.

A closer look at the yield data (Table 11.3) reveals that intensification has occurred primarily in Idete since 2006–8, which has caught up with and outpaced

Table 11.1 Mean cultivated area under rice (ha), three-year average, by village

	2006–8	N	2013–15	N	Difference	Sig.
Idete	0.74	36	1.26	35	0.52	***
Katurukila	1.07	42	1.04	41		

Total number of cases 2006–8: Idete 36, Katurukila 43; total number of cases 2013–15: Idete 36, Katurukila 41. One extreme case was removed in Katurukila for 2006–8 and one extreme case in Idete for 2013–15.

Table 11.2 Mean production of paddy (kg) per household, three-year average, by village

	2006–8	N	2013–15	N	Difference	Sig.
Idete	1127	36	3186	36	2059	***
Katurukila	1708	42	2422	41	714	**

One extreme case was removed in Katurukila for 2006–8.

Table 11.3 Yields (kg/ha) 2006–8, 2013–15

	2006–8	N	2013–15	N	Diff.	Sig.
Idete	1433	36	2464	36	1031	***
Katurukila	1529	42	2222	41	693	***

One extreme case was removed for Katurkila for 2006–8.

the yields in Katurukila since the previous round of data collection. Nonetheless, also in Katurukila yield increases have been pronounced.

The increases in rice production is a general feature, not driven by outliers. It was reported by respondents in the qualitative interviews in both villages. The share of the median as a proportion of the mean increased slightly in both villages meaning that median production rose faster than average production, pointing to slightly improved prospects for the bottom half of the sample (see Table 11.4).

The point that commercialization was one of the main drivers of production increases was repeatedly stressed in focus group discussions and by key informants. In Idete, for instance, the participants in the male focus-group discussion argued that not only had market access improved in general, but also that the production of several varieties of paddy was a competitive advantage in attracting wholesalers to the village.

Table 11.4 Median three-year average household production (kg) and three-year average cultivated area (ha), paddy, by village 2006–8 and 2013–15

	Production		Area	
	2006–8	**2013–15**	**2006–8**	**2013–15**
Idete	840	2693	0.62	1.01
Katurukila	1400	2080	0.93	0.81

Table 11.5 Share of households who sold paddy (market participation) and average amount sold by household, by village, 2008 and 2015

	Market participation (%)			
	2008	**2015**		
Idete	0.83	0.94		
Katurukila	0.86	0.93		
	Average amount of paddy sold per household (kg)			
	2008	**2015**	**Difference**	**Sig.**
Idete	559	1947	1388	***
Katurukila	755	1569	814	**

The role of commercialization is confirmed also by the quantitative data—the share of households participating in the paddy market is near universal, and sale volumes have on average increased dramatically as suggested by the data in Table 11.5. A marketable surplus has emerged between the two rounds of data collection. The qualitative interviews also mentioned the importance of rising prices. The quantitative data suggest that price improvements are part of a long-term trend: the data on price perceptions shows that already in 2008, twenty-two out of twenty-eight respondents in Idete perceived prices to have improved since 2002 and thirty-one out of thirty-eight households in Katurukila agreed. By 2015, nineteen out of thirty-four, and thirty-one out of thirty-eight respondents in Idete and Katurukila respectively were of the opinion that prices had improved since 2008. Steadily improving prices and better market access may therefore offer part of the explanation for what appears to be an agrarian-based process of livelihood improvements, generated by increases in production and yields.

Technology Use and Modes of Technology Transfer

Improved technologies as an explanation for production increases and rising yields was a cross-cutting theme in all interviews—the institutional mechanisms behind this are based on a combination of group dynamics, extension services, immigration, and extension services provided by local level government officials, NGOs, and other organizations. In both villages, the formation of groups for purposes of technology transfers was actively encouraged.

The use of extension services has been largely unchanged in both villages—in the case of Idete 55 per cent of the households in 2015, reported receiving extension, either from government services or private organizations, such as NGOs, during the past year. The corresponding share for Katurukila was 52 per cent. While, there were no statistically significant changes in the extent to which farmers received extension, the increasing formation of groups is reflected in the data for Idete: 10 per cent of the sampled farmers belonged to a local farmer's group in 2008, compared with 29 per cent in 2015 (a difference that was statistically significant at the 1 per cent level).

Indeed, in the rice-growing areas where we have worked especially, the method of working through farmers groups had been propagated by a local government-employed female extension agent. In the past, there had been accusations of laziness and inactivity directed at her by the male farmers. In response, she had sensitized farmers into forming groups, while others had been mobilized by the government through the distribution of subsidized fertilizer, which was based on the formalization of groups. At the time of the interviews in November 2017 there were forty-eight active groups involved in livestock and farming in one village. These groups are self-organized but assisted in drafting constitutions and finally formalized through the approval of the extension agent. The main purpose of the groups in both villages, apart from accessing fertilizer, was to farm collectively on demonstration plots, where the visual effect of production improvements could be exhibited, inspiring change in the village.

Despite the emphasis on improved technologies, as a starting point it can be noted that seed varieties grown are mainly traditional types used for dry rice production. In both villages farmers primarily rely on rain, although in Katurukila rain is complemented with a low-technology farm-led irrigation system. In Idete, in 2008, a handful (six) of households reported that the main variety of rice that was grown was an improved variety, a number that actually dropped by 2015. In Katurukila, by contrast, nine households out of forty-one planted improved varieties as their main variety in 2015, compared with one in 2008. The qualitative data, however, contains detailed information on the types of varieties (SARO and Iyara64) being disseminated by the extension services also in Idete. The mismatch between the quantitative data in this

case, therefore may suggest a misinterpretation of the question or the term 'improved seed'.

The use of inorganic fertilizer varies between the villages, largely a result of differences in soil conditions. In 2015, less than a third (ten) out of thirty-six respondents in Idete used chemical fertilizer. For the remainder, the majority stated that their soils were fertile and therefore they did not need fertilizer, while the rest could not afford to buy fertilizer. In Katurukila, by contrast three-quarters of the households used chemical fertilizer and only one household did not do so because of high soil fertility. Here, also the use of fertilizer has increased since 2008: only seven households used fertilizer on rice in 2008, compared with thirty in 2015. The use of pesticides varied between the villages—in Idete 14 per cent of the households used pesticides on rice, whereas in Katurukila 46 per cent did in 2015 (sig. at the 5 per cent level). Data for herbicide use was not collected during 2008, but it should be noted that farmers in both villages, and Idete especially make use of herbicides—81 per cent of the households in Idete, and 46 per cent of those in Katurukila used herbicides on paddy in 2015. Increased use of herbicides was also put forth as an explanation for rising yields in the case of Idete.

Shifting Rural-Urban Economic Opportunities as Explanations of Technology Transfer

An important, if not the main, driver of intensification may come from beyond the villages. The proliferation of relatively inexpensive agricultural machinery is clear in both villages, and also along the roads leading into the villages. The growing availability of tractors and combine harvesters are mentioned as an explanation both for increasing farm sizes as well as higher productivity in both villages. This could be a result of the government Kilimo Kwanza (which translates to 'Agriculture First') initiative in which Pillar No. 7 aims at industrialization to promote agriculture by addressing the needs of agricultural producers. Backward linkages through supply of agricultural machinery and implements was a government priority in this context. Moreover, through the agriculture window of the Tanzania Investment Bank, individual farmers and farmer groups could access finance for machinery and implements to enhance mechanization.

Investing in tractors and agricultural machines that can be rented to small-scale farmers has become a business opportunity in Morogoro and other smaller urban centres. Informants in Katurukila argued, that opportunities for making money in the urban economy have gradually dwindled as part of the government's clamp-down on corruption and tendering procedures and this has led to investments in the agricultural sector.

Changes in land preparation are striking, especially in Idete, where less than a quarter of the households used tractors for land preparation in 2008, compared with 83 per cent in 2015. In Katurukila, tractor ploughing was more frequent in 2008, but also increased during the period, with 70 per cent of the farmers preparing their land by using a tractor in 2015. Labour shortage in the villages could also explain this shift. The secondary education system from 2004 to 2009 through the Secondary Education Development Program (SEDP) phase 1 tripled the number of secondary schools in the country. This meant that more youth in the villages could now attend secondary school, thus withdrawing them from engaging in farm activities. The second phase of SEDP with assistance of the World Bank started in 2010 and further increased the access of many youth to secondary education. The farming population is thus ageing, and replacement is minimal. Mechanization and productivity improvements are a response to demographic change that is driven partly by the expansion of education.

Land Use Changes—Growing Demand, Formalization, and Individualization

Further explanation for broader livelihood changes and the dynamics between productivity increase are related to two aspects noted in the qualitative data: on the one hand the growing commercial prospects in paddy raise the value of land and enable poorer households to rent out land to urbanites or farmers from other villages keen to explore such prospects. In turn, it was suggested that this raises incomes and living standards among the landholders.

A second change that was noted was the individualization of farming, especially for women, either through renting land or through land rights that were being individualized through the titling schemes being rolled out in the villages. At the time of the quantitative data collection the latter had not been completed, nor is it possible to trace intra-household control and access to land through this dataset. The argument was nonetheless made in focus group discussions with both men and women as well as in the interviews with extension staff, that the possibilities for women individually to cultivate land, especially through renting land, was improving productivity. The incentives for women's production on such land were higher than on family land, given the general understanding that the income generated from sale of produce from land that women themselves were renting would be kept by the wife. The re-investment of incomes into improved housing by women and the general demonstration effect of women engaging successfully in agriculture were also noted as sources of rising productivity in discussions with male respondents. Husbands would gradually be convinced by the improvements being made, overcoming their hesitation to adopt new technology.

While the growing value of land cannot be captured in increases in productivity among the sampled households, for 2015, we have nonetheless documented the existence of a rental land market. In both villages, renting out land was less frequent than renting in land: in Idete, 32 per cent of the households rented land, while 26 per cent rented out land, compared with Katurukila, where 40 per cent of households rented in land and 19 per cent rented out land. The average total cultivated area is the same in both village, 2.1 hectares. The share of rented land of total farm size (which includes both cultivated area as well as land under fallow) points to a strong reliance on the rental market: 55 per cent and 57 per cent respectively of total farm size consisted of land rented in for the twelve households in Idete and the seventeen in Katurukila who stated that they rented land. There is a strong negative correlation (–0.39 significant at the 5 per cent level), between the share of rented land and total farm size, raising concerns about the vulnerability of small-scale households in the rental market. Losses of land were also frequent in Idete, where 26 per cent of the respondents stated that they had lost land that they considered they had the right to cultivate. Unlike the qualitative data, the quantitative data, do not suggest that land is being rented out by the poorer households for the benefit of both parties, but rather that the poorer households are reliant on the rental market for the bulk of their cultivated area.

Concluding Remarks

This case study from two Tanzanian villages in Kilombero District shows the potential of a rice-led, smallholder based agricultural transformation process in an African context. Rice production on average had increased more than area under cultivation in both villages pointing to processes of both intensification and expansion. They demonstrate that remarkable increases in productivity are possible in small-holder farming systems. Some interventions recently have insisted that only step changes which move labour out of unproductive agricultural sectors can bring about the growth poor countries need (Collier and Dercon 2014). This may be the case in the long term, over the decades those authors were considering. But the productivity gap between agriculture and other sectors may be over-estimated (McCullough 2017). The transformations possible we have documented in smallholder farming suggest that routes to higher productivity can be built on this sector.

We identify four factors that have been of importance as main drivers of these growth processes. First, commercialization and market expansion due to diversification of paddy varieties and improved prices have provided economic incentives for farmers to specialize in paddy and increase production. Second, technological change in the form of mechanization and new farm in-puts, e.g. up-graded rice varieties has increased land productivity. Thirdly, improved access

to extension services and the introduction of new farming practices has also contributed to these dynamics. Finally, an individualization of production, where family members work on their private fields rather than on jointly owned land, has motivated intensified efforts to increase production.

While technological change and the diffusion of innovations was a pivotal aspect also of the Asian Green Revolution, in the case of Idete and Katurukila, this rests on the uptake and transfer of technology through group dynamics and immigration, which may be unique to the villages. A key question in this context is whether such processes are replicable to other geographical and institutional settings?

Linkages to the outside economy have been a mixed blessing: on the one hand the relative benefits of investing in rural areas have enhanced or even sparked mechanization in the areas, on the other hand, growing pressure and demand for land could cause stratification as already vulnerable segments of the population become even more vulnerable (Greco 2015).

Meanwhile, the growing pressure on land and the government push for formalizing land titling has had the unintended consequence that farming is becoming increasingly individualized, which has had a positive effect on women farmers especially. Individualized tenure is also prompted by the will to benefit from improved prices among both women and men. In the event, the ability to engage in individual farming on rented land is put forth as an explanation of the rising productivity among women.

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