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8

Policies or Prices? A Gendered Analysis of Drivers of Maize Production in Malawi and Zambia, 2002–13

Martin Prowse and Ellen Hillbom

Introduction

Ever since its introduction some 500 years ago, maize has played an important role in processes of long-term economic, political, and social change in Africa. It has to a large extent supplanted the continent's own historical grain crops such as sorghum and millet, and has supported increasing populations (McCann 2005). White maize dominates food consumption in Eastern and Southern Africa and accounts for more than half the calories people consume. Although many rural households in Malawi and Zambia are net food purchasers, almost all of them produce maize for consumption. While demand for maize is expected to stay high in the foreseeable future (Byerlee et al. 2006, Jayne et al. 2010), the deepening of agricultural markets (due to changing food preferences, urbanization, and population growth) as well as better local, national, and regional labour markets, provide contemporary smallholders with a growing range of opportunities for diversification of agricultural production and livelihood strategies. Under such circumstances it is pertinent to ask to what extent and how smallholders are motivated to improve productivity.

In this chapter, we pursue this line of questioning by using Afrint data from Malawi and Zambia during the period 2002 to 2013. The comparison is instructive as both neighbours are landlocked and share some linguistic, matrilineal, and colonial similarities. However, they also differ in terms of population densities, landholding sizes, industrial structure, and policies encouraging smallholder production. The chapter applies an explicit gender

lens to examine if we can detect differences in maize farming by comparing farms managed by men and women. We locate the study within each country's historical context of post-independence government agricultural policies with a particular focus on price stabilization and subsidy schemes. As the Afrint I, II, and III rounds of data correspond with the most recent rise and fall in global price on maize, we also explicitly investigate the extent to which the global commodity boom of the early 2000s influenced smallholder production. Further, we utilize qualitative data collected in Malawi and Zambia in 2012 and 2016 in the form of semi-structured interviews with key informants and household respondents as well as focus group discussions to elaborate on the results obtained from the Afrint panel data.

The structure of the chapter is as follows. In the next section we examine the basic trends in maize production and productivity in Malawi and Zambia from Afrint I to III. We then contextualize long-term government agricultural strategies. Following this, we discuss the expected relationship between hikes in global maize prices and national producer prices. We then turn to the Afrint data presenting changes in maize production during 2002–13 across farms managed by men and women. Next, we conduct a production function to assess the relative contribution of household-level factors to productivity increases. Thereafter we turn to the qualitative data and the last section concludes.

Trends in Maize Production and Productivity in Malawi and Zambia, 2000–14

Figure 8.1 details recent country-level trends in maize production in Malawi and Zambia based on FAO data.¹ The data cover all farm sizes and all types of maize, although both Malawi and Zambia produce almost exclusively white maize. Production increased from 2.5 to 3.92 million metric tons ($r^2 = 0.711$) and from 1.04 to 3.35 million metric tons ($r^2 = 0.813$) in Malawi and Zambia, respectively. This trend is significant in both countries at the 1 per cent level using a one-sample t-test and corresponds to an annual growth rate of around 7 per cent and 11 per cent respectively. When we conduct a linear regression trend analysis for both countries it shows significance at the 1 per cent level (although the Zambian data do show signs of serial autocorrelation as measured by the Durbin–Watson test). In per capita terms, though, this absolute increase in maize production corresponds to stagnation in Malawi from 220 kg to 226 kg per capita compared to a rapid increase in Zambia from 103 kg to

¹ We recognize that these FAO data may be noisier than comparable Ministry of Agriculture data

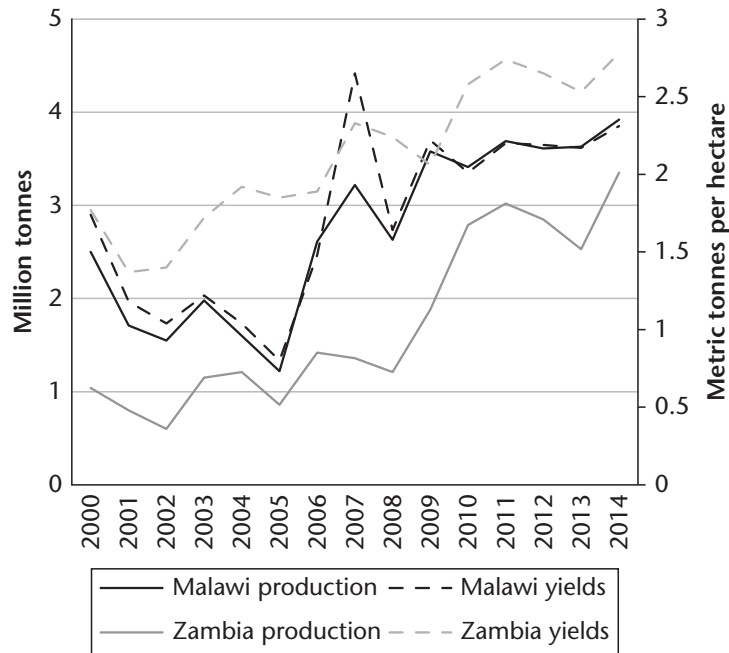


Figure 8.1 Trends in maize production (million tons) and yields (metric tons per hectare) in Malawi and Zambia, 2000–14.
 Source: FAOSTAT, April 2016.

220 kg per capita.² Figure 8.1 also shows that yields, i.e. land productivity, have increased in both countries. In Malawi we see an increase from 1.74 to 2.31 tons per hectare ($r^2 = 0.51$) while the Zambian data show an increase from 1.77 to 2.78 tons per hectare ($r^2 = 0.85$). This corresponds to growth rates of 6 per cent and 5 per cent respectively. Both one-sample t-tests and linear regression trend analysis show significance at the 1 per cent level.

While capturing changes in production and productivity, these numbers do not, however, disclose which segments of maize producers are driving national trends: large- or small-scale farmers. Later in the chapter we return to this issue as we investigate to what extent and through which mechanisms smallholders in Afrint villages are part of the national trends.

State Intervention for Agricultural Development

Agricultural policies in Malawi after independence in 1964 initially focused on promoting smallholder production on customary land (Kydd 1984, Mkandawire

² Population estimates from the World Development Indicators and World Population Review for 2000 and 2014, respectively.

and Trust 1999). Part of this strategy was the reform of the agricultural extension and marketing services provided by the Farmers' Marketing Board. The state's increased control over every aspect of agricultural production and marketing during the 1960s, and the harsh penalties levied if these regulations were contravened, prevented both settlers and African intermediaries from competing with the Farmers' Marketing Board in the marketing of food and cash crops (Ng'ong'ola 1986). Due partly to a limited supply response from smallholder agriculture, and facing a balance of payments crisis (Baker 1962, Thomas 1975), the early 1970s saw a switch in government policy away from the smallholder sector towards estates as a source of agricultural growth (McCracken 1984). The smallholder sub-sector was now viewed as a source of labour, as well as playing a role in the construction of the nation through providing maize for both rural and urban populations. This was achieved through the parastatal Agricultural Development and Marketing Corporation (ADMARC) offering fertilizer subsidies and high pan-territorial and pan-seasonal producer prices for maize. Meanwhile, consumer prices for maize were also subsidized. This state-led model worked relatively well until the end of the 1970s when decline in terms of trade, increases in international interest rates, drought, and the disruption of export routes exposed the frailties of the dualistic agricultural development strategy (Ng'ong'ola 1986, Harrigan 2001, Van Donge 2002).

In response to the economic crisis, the government opened negotiations with the International Monetary Fund and the World Bank, and structural adjustment programmes were introduced. During the 1980s, subsidies for maize seeds and fertilizers were phased out, and the producer price of maize was reduced relative to export crops (Lele 1990, Kherallah and Govindan 1999, Harrigan 2001). Harrigan (2001) argues that the consequence of increasing producer prices for export crops, while holding ADMARC maize prices stable, was production switching from maize to fire-cured tobacco, groundnuts, and cotton. This reduction in maize hectareage was exacerbated by the removal of the fertilizer subsidy programme which reduced the profitability of maize, especially high-yielding varieties. These factors, along with the financial collapse of ADMARC, reduced maize production and precipitated a national food crisis in 1987, causing government to reintroduce fertilizer subsidies and increase maize producer prices (Harrigan 2005).

In the late 1990s there was a 'policy vacuum' regarding food production in Malawi. Government and donors implemented a piecemeal reactive series of measures (Harrigan 2003). The 1996/7 and 1997/8 agricultural seasons saw a dramatic decline in maize production. From the 1998/9 agricultural season a Starter Pack scheme reversed this trend, contributing to bumper maize harvests in 1998/9 and 1999/2000. In subsequent years, Starter Pack was accused of crowding out the private sector, fostering smallholder dependency on hand outs, and being overly bureaucratic (Harrigan 2005, Levy 2005), and it evolved

into a 'targeted' social safety net in the form of the Targeted Input Programme (TIP). Two events which shook policymakers into action were the regional food security crises of 2001/2 and 2005/6. Policymakers responded by implementing input subsidies to boost maize production and productivity. The creation of Malawi's Farm Input Subsidy Programme in the 2005/6 season more than doubled maize production from 1.2 million to 2.6 million metric tons. Between the 2006/7 and 2013/14 seasons, production only dropped below 3 million metric tons in 2007/8 (Chirwa and Dorward 2013, Arndt et al. 2016).

Meanwhile, in Zambia the colonial era saw the establishment of the mining sector as the main export earner, and the rural areas as providers of labour and food. Preferential policies were developed with the purpose of creating a smaller group of commercialized maize farmers, initially settlers but later including Africans (Gann 1969). After independence in 1964, the government chose to subsidize agricultural inputs to continue stimulating maize production by the commercial sector to feed its (relatively, in African terms) large share of urban population, but also to encourage smallholder production. While large-scale farmers demonstrated significant progress based on mechanization, subsidies, new hybrid varieties, and farming on marginal lands, the smallholder sector also improved. Overall, from the early 1960s to the late 1980s, Zambian farmers increased their maize production by 400 per cent (McCann 2005: 162). However, the economic crisis in the 1980s and early 1990s resulted in structural adjustment reforms which required a significant reduction of subsidies. The lack of extension and credit for hybrid maize production as well as market prices for fertilizer caused many smallholders to revert to indigenous crops such as sorghum, millet, beans, and groundnuts (Jayne and Jones 1997: 166, Govereh and Jayne 2003, McCann 2005).

In 1995 the Food Reserve Agency (FRA) was established as a parastatal strategic food reserve/marketing board with a mission to buy maize at a pan-territorial price exceeding wholesale prices in major maize-producing areas. The FRA's price policies included, for example, offering farmers above-market prices, subsidizing prices to select large-scale millers, and exporting regionally (even at prices below the FRA purchasing price). FRA activities have both made maize prices more stable and raised them above average market prices, by as much as 17–19 per cent for the 2003–8 period. Between the 2004/5 and 2010/11 growing seasons the FRA purchased 30–86 per cent of maize marketed by smallholders, costing the government roughly 25 per cent of the annual total agricultural sector budget (Mason and Myers 2013). The FRA's interventions in output markets and price control represent active state policies that set Zambia and Malawi apart. While in theory all smallholders can sell maize to the FRA, unreliability and delays of payments by the parastatal entice those in urgent need of cash to seek alternative buyers of their produce, often selling

well below the prices set by the government. Further, many cooperatives profit from the opportunities represented by the price gap, turning into maize-trading, rather than maize-producing, groups. Finally, the use of the FRA's pricing mechanisms to boost incomes of certain cooperatives and private agents has contributed to the considerable growth of medium-scale and large-scale commercially oriented farming, and increased the gap between them and the small-scale subsistence farmers (Sitko and Jayne 2014b, Andersson Djurfeldt and Hillbom 2016).

As a complement to the FRA, the Fertilizer Credit Program was created in 1997/8 with a small subsidy attached (Mason et al. 2012). In the 2002/3 season, large-scale fertilizer subsidies were reintroduced. During the three years the programme ran, on average 29,000 metric tons of fertilizers were distributed annually, particularly to the major maize-producing regions in the Central, Eastern, and Southern provinces. However, repayment rates were poor, and the next programme, the Fertilizer Support Program, was designed as a cash-only input subsidy programme targeting selected beneficiary farmers. Annual volumes were slightly more than double compared to the previous programme, and beneficiaries were somewhat more evenly distributed over the country. In 2009/10 the programme was renamed the Farmers Input Support Program (FISP), and it was still running at the time of Afrint III. The volume and number of recipients has been substantially increased from 48,000 metric tons of fertilizers and 120,000 farmers in 2002/3 to 180,000 metric tons and 900,000 farmers ten years later (Ricker-Gilbert et al. 2013). FISP is open to households with more than 0.5 ha of land and it is delivered through registered farmer groups such as cooperatives. These principles mean that the programme excludes 15–20 per cent of the poorest rural households in the country (Sitko and Jayne 2014b).

The fertilizer subsidy schemes in both Malawi and Zambia have been contentious (see Chinsinga and O'Brien 2008, Chirwa and Dorward 2013, Sitko and Jayne 2014b, Arndt et al. 2016, Ricker-Gilbert and Jayne 2017). The challenges for implementation of fertilizer subsidies in both countries stems from two forms of market failure. First, the slow process of rolling back the state within agricultural input markets created an uncertain policy environment, which resulted in thin fertilizer markets in both countries characterized by lack of authentic competition and penetration into all regions. In addition to the overriding political imperative of assuring national-level food security in the context of uncertain climatic conditions, imperfections within fertilizer supply have exacerbated maize price volatility (including speculation by, e.g., maize-trading cooperatives in Zambia), placing pressure on the social contract in both countries. The second form of market failure has been in credit markets. Since the late 1990s, financial institutions have not been able to offer credit to smallholders to intensify maize production on a sustainable

basis due to them consistently prioritizing immediate consumption needs over longer-term repayment considerations.

Reflecting the focus of this chapter, gender has increasingly been integrated within national policy frameworks in both countries. Within Malawi, the overarching Agricultural Sector-Wide Approach (ASWAp) aims to ensure that half of participants in programmes, such as the FISP and the Green Belt initiative on irrigation, are women. The ASWAp recognizes that women-headed households have worse access to land, labour, and credit than male-headed counterparts and, similar to the national gender policy, increase women's control over agricultural resources and technologies. In Zambia, gender within agriculture is conspicuous by its absence: the Sixth National Development Plan relegates gender to being 'mainstreamed' and delegates coordination to the Ministry of Gender and Child Development. Gender also remains marginal within the National Agricultural Investment Plan (NAIP): it is seen as a cross-cutting issue. The main positive statement in the NAIP is the goal that 30 per cent of targeted beneficiaries are to be women.

Global and National Maize Prices, 2002–14

After around twenty-five years of decline, internationally traded food commodity prices started to increase sharply from January 2005 to June 2008 (Mitchell 2008, Piesse and Thirtle 2009). Being both a significant staple food crop in much of the developing world and having multiple uses including food, feed, and fuel, maize was at the core of the food commodity price boom, with prices tripling (Rosegrant 2008, Piesse and Thirtle 2009). After their peak in 2008, cereal prices declined by a quarter, only to increase rapidly again in 2011/12 before subsiding to below 2007 levels in early 2015 (World Bank 2015). Maize prices broadly reflect these general trends, showing a 20 per cent decline up to the year ending May 2015 (World Bank 2015). Biofuels were initially seen as a window of opportunity for African smallholders and a route to pro-poor agricultural growth (Von Braun and Pachauri 2006, Peskett et al. 2007). However, it became increasingly clear that the biofuel boom (itself driven by high oil prices) was driving higher food prices as broader crops, e.g. maize, were close substitutes in consumption and production (Mitchell 2008, Rosegrant 2008).

The percolation of increasing prices on international markets to national producer prices benefitting the commercialized smallholder population in countries such as Malawi and Zambia should not be taken for granted. The development challenge inherent in occupying a relatively remote geographical location lies in high transportation costs, making it difficult to realize gains from trade. These challenges are particularly severe for countries

Maize Production in Malawi and Zambia, 2002–13

with underdeveloped technology and infrastructure and a reliance on passage through sovereign transit countries (Sachs and Warner 1997, Mitchell 2008: 5). Not surprisingly, there is strong evidence that a country's level of infrastructure development, i.e. transportation costs, is associated with its level of agricultural productivity (Antle 1983, Gollin and Rogerson 2014). Further, when a high import/export parity wedge and underdeveloped domestic markets are combined with high domestic production variability, the impact of domestic shocks such as droughts is increased. Consequently, domestic price instability tends to be highest in landlocked African countries (Byerlee et al. 2006: 277). Meanwhile, regional trade, in combination with good transportation infrastructure between countries, has the potential to expand the size of the market and reduce price instability (Dorosh et al. 2009).

In Figure 8.2 we plot the development of national producer prices for white maize in Malawi and Zambia for 2002–14. The data show that the basic trends to a significant degree conform with the global hike in maize prices, though there are variations. First, the sharp increase in prices is delayed and not recorded until 2007. Second, while prices are high in 2008 the final peak is in 2009. Third, as is the case for global prices, national prices turn down, but

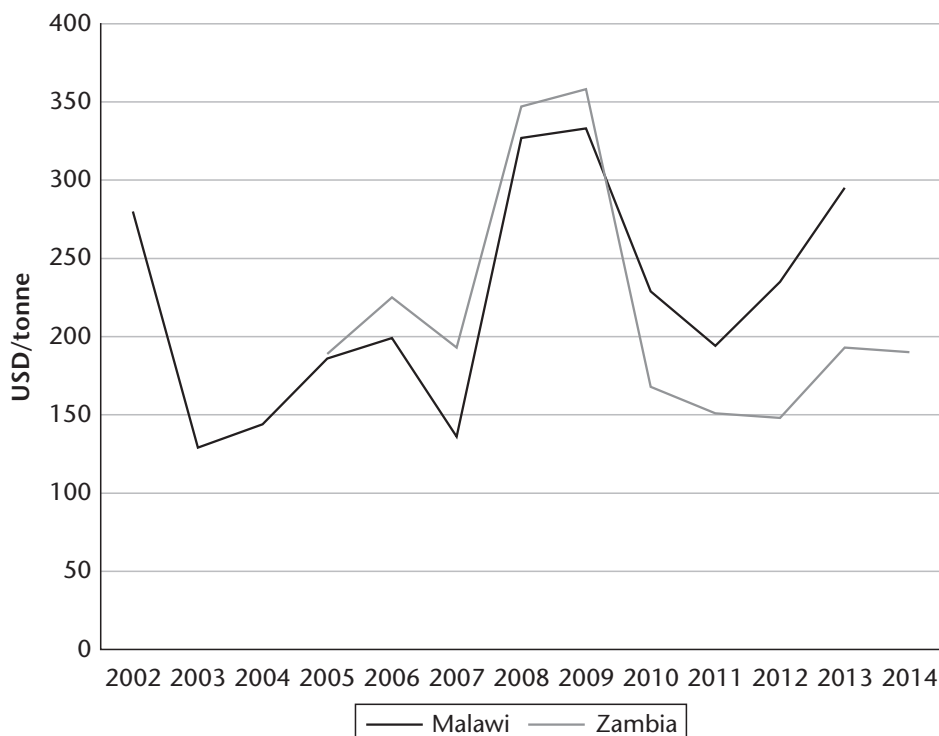


Figure 8.2 National white maize producer prices in USD/ton in Malawi and Zambia, 2002–14.

Source: FAOSTAT, April 2016.

increase again somewhat in 2011. In sum, during our period of investigation, 2002–13, national producer prices for white maize are about the same at the beginning and at the end of the period in both Malawi and Zambia, but in between there is a price hike stretching from 2007 to 2009/10.

While the commodity boom left net developing-country consumers living in poverty vulnerable to increasing food prices, it also created opportunities for primary sector-based economies to profit by increasing their own production (Helbling et al. 2008). In the rearticulation of smallholder-led agricultural development around the turn of the millennium, it was argued that smallholders broadly respond to market incentives, including price movements (World Bank 2007). Hikes in food prices, including maize, could thereby be seen as constituting a window of opportunity for producers. Scholars have indeed found that higher profits from maize production caused African farmers generally to shift to maize cultivation (Rosegrant 2008, Ghosh 2010, Jayne et al. 2010), but we want to see to what extent the hike in national maize prices influenced Afrint smallholders' maize production in Malawi and Zambia specifically.

Descriptive Statistics

We build on the three rounds of Afrint quantitative household data, described in Chapter 1. As far as possible, we conduct consistent comparisons between households with men and women as farm managers, referred to as male-managed farms (MFMs) and female-managed farms (FMFs) respectively. The three waves of data show considerable mobility between these household categories. As we do not have a variable for sex of farm manager for Afrint I, we are forced to use the household headship variable as a proxy. Within the Malawian data we have 268 households in the panel covering both waves. Afrint I shows 195 male-headed households (73 per cent) and seventy-three women-headed households (27 per cent). In Afrint II, we see an increase in the balance of women with 118 households (44 per cent) containing FMFs compared to 150 MFMs (56 per cent). In Afrint III, we see a reduction again to ninety-nine FMFs (37 per cent) vs 169 MFMs (63 per cent). To ensure we are truly tracking the same households through time, we only use data from the 145 MFM households and ninety FMF households which display the same household categorization throughout both waves (all three cross-sections) of the dataset. In other words, we exclude the households which changed household status through the duration of the panel. The proportion of women managing farms in the Zambian panel of 276 households showed similar levels of mobility between categories, and again we only use the households

which we are certain had the same gender of farm manager throughout the period of investigation.

Table 8.1 presents selected descriptive statistics of relevance for our investigation, i.e. trends in maize production, area under maize farming, yields, and use of fertilizers. It is based on true panel households across both waves in Malawi and Zambia, and shows results for all households as well as for male and female farm managers separately. Significance is assessed through paired-sample t-tests.

As expected, the application of fertilizer to maize has increased during 2002–13 for all farm categories. In both countries, men have increased the application of fertilizer to a much greater extent than women: in Zambia by 210 kg more, in Malawi by around 47 kg more. Overall, maize production has increased significantly during the period in question: by 22 per cent in Malawi and by a staggering 239 per cent in Zambia. This means that trends in national maize production that we noted earlier are not driven by large-scale farms only, rather the increase in production in the smallholder sector is higher than the national average, and significantly so in Zambia. While households in Zambia were producing around double their Malawian counterparts in Afrint I, by Afrint III this had grown to more than a factor of four. Increases in maize production are coming from farms managed by men, not women. In statistical terms, farms managed by women did not see any significant changes in maize production between Afrint I and Afrint III. However, yields have increased dramatically in both countries for farms managed by women. In Malawi, women increased yields by 26 per cent compared to 47 per cent for men. In Zambia, women increased yields by 51 per cent compared to men's increase of 84 per cent.

At the same time as maize production is increasing, MMFs in Malawi have reduced land allocated to maize from 0.95 to 0.88 ha, and FMFs in Malawi have reduced the area under maize by 0.19 ha. Meanwhile, the story is the opposite in Zambia, where men have increasing land under maize from 1.47 to 1.88 ha and women have increased land under maize, although to a slightly lesser extent (and the result is not significant). For Malawi these results resonate with the trends found at the national level and supports the conclusion that increased maize production is a process characterized by intensification. This is a land-scarce country, which is demonstrated by national numbers reporting 183 people per square km (World Bank 2016). The qualitative Afrint data show that the sampled sites in Malawi generally follow the national trends reporting high levels of population density. In Zambia, while the national trend pointed towards intensification, the Afrint data indicate that for the smallholder population increased maize production is instead a story of extensification. National population density levels are at low, at twenty-two people per square km (World Bank 2016), but the Afrint sites in Mazabuka and

Table 8.1. Maize area, production, and yield for all households with male and female farm managers in Malawi and Zambia, Afrint I–III

	Area under maize, 3-year average (ha)										NPK application to maize (kg)									
	All			Male			Female			All			Male			Female				
	I	III		I	III		I	III		I	III		I	III		I	III			
Malawi	Mean	0.90	0.79	0.95	0.88	0.82	0.63	32.18	136.14	34.47	154.05	27.79	101.69	No.	232	143	89	152	100	52
	S.D.	0.51	0.56	0.49	0.62	0.52	0.40	51.97	137.28	52.36	158.35	51.44	72.68	Sig.	***		***		***	
Zambia	Mean	1.40	1.76	1.47	1.88	0.97	1.04	214.27	526.51	227.68	575.77	149.11	287.21	No.	198	169	29	164	136	28
	S.D.	1.05	1.42	1.07	1.48	0.81	0.67	398.45	595.67	428.94	618.06	182.13	400.55	Sig.	***	***		***		***

	Maize production (kg)										Yields (kg per hectare), based on pruned area data									
	All			Male			Female			All			Male			Female				
	I	III		I	III		I	III		I	III		I	III		I	III			
Malawi	Mean	745.43	906.38	801.72	1,098.25	652.95	591.17	879.35	1,225.69	903.08	1,326.77	840.95	1,062.02	No.	222	138	84	220	136	84
	S.D.	645.31	1,034.23	600.81	1,213.89	706.45	506.45	616.81	876.31	688.35	947.06	480.37	723.55	Sig.	**	*		***		***
Zambia	Mean	1,655.23	3,951.37	1,721.94	4,442.46	1,330.86	1,651.15	1,143.97	1,998.63	1,158.75	2,125.41	1,072.64	1,618.68	No.	170	141	29	169	140	29
	S.D.	2,219.82	5,247.31	2,322.05	5,606.03	1,627.97	1,554.33	716.42	1,196.95	717.90	1,238.32	717.43	873.70	Sig.	***	***		***		***

Maize Production in Malawi and Zambia, 2002–13

Table 8.2. To what extent do the trends in maize cultivation differ between households with male and female farm managers?

		Area under maize, 3-year average, change Afrint I–III (ha)		NPK application to maize, change Afrint I–III (kg)		Maize production, change Afrint I–III (kg)		Yields (kg/ha), using pruned area data	
		Male	Female	Male	Female	Male	Female	Male	Female
Malawi	No.	143	89	100	52	138	84	136	84
	Mean	−0.18	−0.07	119.58	73.90	296.52	−61.77	423.70	221.07
	S.D.	0.6	0.71	154.69	75.70	1263.51	822.66	1,078.32	779.41
	Sig.			**		**			
Zambia	No.	169	29	138	28	141	29	29	140
	Mean	0.41	0.07	348.09	138.11	2,702.53	320.29	546.04	966.66
	S.D.	1.51	1.01	638.99	393.72	5,486.70	2,182.36	1,115.69	1,407.92
	Sig.			*		**			

Mkushi show regional differences. While smallholders in Mkushi state that much of their arable land is left idle, in Mazabuka this is not the case. Nevertheless, it seems that Afrint smallholders have sufficient land to extend rather than intensify their farming. Table 8.2 confirms the findings from paired-sample t-tests and shows through independent sample t-tests that men significantly increased fertilizer application and maize production to a greater extent than women, but that changes in area and productivity between MMFs and FMFs show no significance.

Production Function on Malawian and Zambian Data

To further explore changes in production and productivity we now turn to assessing the relative importance of a number of household factors. We follow the conventional specification of a production function as described in Peterman et al. (2011), logging both sides of the equation. As our dependent variable is normally distributed, we use a logged ordinary least squares regression model. To cover the full period of the project we use Panel I and Panel II data. For each country, we pool data for households with male and female farm managers and include gender of farm manager as a dummy to see how it influences productivity. Second, we run the same model stepwise with gender of farm manager introduced in Block 2 to compare coefficients and how the inclusion of gender of farm manager alters the model.

In previous sections we hypothesized that government policies generally and fertilizer subsidies specifically, as well as national producer prices, could be expected to influence smallholder maize yields (the dependent variable). To capture government policies in the model we have included the use of NKP

Agriculture, Diversification, and Gender in Rural Africa

(fertilizers) and improved seeds in both countries. In addition, as the qualitative data for Zambia informed us that extension officers' promotion of specific conservation farming techniques, i.e. ripping, was deemed to have considerable positive effects on maize production, this variable was also included, but only for Zambia. Maize prices are complimented with two spatial variables: distance to market and village centre. Further, we look into smallholders' access to the two basic factors of production—land and labour. For land we include size of land used for maize production and for the quantity of labour we have number of able workers and hiring of temporary farm hands, so-called *ganyu* in Malawi. We also have more qualitative aspects of labour captured by age and years of schooling of farm manager. Finally, we capture the gender perspective as sex of farm manager.

We discussed earlier how the longitudinal study limited the sample size as we use data from true panel households. The pruning of continuous variables further reduces the number of cases available for the ordinary least squares regression model. Despite these limitations, we obtain significant results. Descriptive statistics for the Malawian model with relevant transformations of variables are shown in Table 8.3. Missing values for some continuous variables have been imputed using median or mean figures. Skewness and

Table 8.3. Descriptive statistics for Malawian production function

	N	Mean	Std. deviation
	statistic	statistic	statistic
<i>Dependent</i>			
Yields—pruned at 3SDs, logged	138	7.86	0.32
<i>Independent</i>			
Age of head of household, years—68, missing values imputed with mean	138	6.36	0.95
Years of schooling of farm manager—2013 variable logged, 7 values imputed with median	138	1.29	0.75
Estimate of trend in able workers Afrint I to III, plus constant, logged, 5 missing values imputed with median	138	1.64	0.36
Trend in maize area Afrint I to III—pruned at 3SDs, plus constant, logged, 7 missing values imputed with median	138	1.02	0.19
Ganyu nominal trend Afrint II to III, plus constant, logged, 2 missing value imputed with median	138	4.24	0.50
NPK trend Afrint I to III— pruned at 3SDs, plus constant logged	138	5.61	0.54
Started using improved seeds between Afrint I to III, dummy	138	0.39	0.49
Started hiring labour in between Afrint I to III, dummy	138	0.25	0.43
Distance to market, household level, logged, 2008	138	1.86	0.64
Distance to village centre, logged, 2013, missing values imputed	138	−1.07	1.23
Trend in maize prices in USD nominal from Afrint II to III, no outliers, plus constant, logged	138	2.74	0.30
Dummy for sex of farm manager consistent across 2008 and 2013 with 2001 household head	138	0.64	0.48

Maize Production in Malawi and Zambia, 2002–13

kurtosis are below accepted limits. Listwise, 138 units are available for the production function. Table 8.4 shows coefficients for the model alongside significance figures. Collinearity statistics are within limits with variance inflation factors of variables below 1.2. The distribution of residuals is normal. Overall, the model explains 39 per cent of the variance of change in maize yields.

Table 8.4 shows that five independent variables are significant. The trend in maize area shows a strong negative relationship (–0.39) with maize yields at

Table 8.4. Coefficients for Malawian production function

Model	Unstandardized coefficients		Standardized coefficients	Sig.
	B	Std. error	Beta	
(constant)	7.448	0.433		***
Age of head of household, years—68 missing values imputed with mean	–0.056	0.025	–0.163	**
Years of schooling of farm manager—2013 variable logged, 7 values imputed with median	–0.009	0.030	–0.020	
Estimate of trend in able workers Afrint I to III, plus constant, logged, 5 missing values imputed with median	–0.017	0.064	–0.019	
Trend in maize area Afrint I to III—pruned at 3SDs, plus constant, logged, 7 missing values imputed with median	–0.669	0.123	–0.386	***
Ganyu nominal trend Afrint II to III, plus constant, logged, 2 missing value imputed with median	0.006	0.045	0.009	
NPK trend Afrint I to III— pruned at 3SDs, plus constant logged	0.284	0.041	0.476	***
Started using improved seeds between Afrint I to III, dummy	–0.030	0.047	–0.046	
Started hiring labour in between Afrint I to III, dummy	0.038	0.051	0.050	
Distance to market, household level, logged, 2008	0.100	0.035	0.198	***
Distance to village centre, logged, 2013, missing values imputed	0.049	0.018	0.186	***
Trend in maize prices in USD nominal from Afrint II to III, no outliers, plus constant, logged	–0.098	0.074	–0.091	
Dummy for sex of farm manager consistent across 2008 and 2013 with 2001 household head	0.003	0.048	0.004	
Model summary				
Model	<i>r</i>	<i>r</i> ²	Adjusted <i>r</i> ²	Std. error of the estimate
1	0.668a	0.447	0.394	0.25162

Notes: a. B is the symbol used for an unstandardized ordinary least squares regression coefficient.

Agriculture, Diversification, and Gender in Rural Africa

the 1 per cent level. Holding all else equal, the trend in fertilizer application shows a strong positive relationship (0.48) with the trend in maize yields at the 1 per cent level. Two spatial variables show weak positive and significant relationships with the trend in maize yields: distance to market (0.20) and distance to the village centre (0.19), both at the 1 per cent level. The direction of these relationships is counter-intuitive: one would expect households closer to density and markets to have higher levels of productivity. Finally, age shows a negative relationship (-0.16) at the 5 per cent level.

Table 8.4 also shows that counter to our initial assumptions regarding the impact of price incentives, the logged trend in maize price variable does not show any significance (although the construction of the indicator does not, at present, allow for a lagged supply response). Finally, the variable for gender of farm manager is insignificant. When the model is run stepwise with gender of farm manager inserted in Block 2, very marginal changes are detected, none of which alter significance levels of any variables. Thus, the data suggest that, despite a slightly different strategy towards maize cultivation during the period under question, households with female farm managers have been sharing in the productivity increases enjoyed by households with male farm managers, and are subject to the same broad influences in productivity.

Moving on, descriptive statistics for the Zambian model are shown in Table 8.5. In a similar fashion to the Malawian model, missing values have

Table 8.5. Descriptive statistics for Zambian production function

	N	Mean	Std. deviation
	statistic	statistic	statistic
<i>Dependent</i>			
Yields—pruned at 3SDs, plus constant, logged	151	7.98	0.46
<i>Independent</i>			
Age of head of household, years—square rooted, 9 missing values imputed with mean	151	6.70	1.03
Years of schooling of farm manager—2013 variable logged, 6 values imputed with mean	151	1.92	0.63
Estimate of trend in able workers Afrint I to III, plus constant, logged	151	2.58	0.29
Trend in maize area Afrint I to III, pruned at 3SDs, plus constant, logged, 7 missing values imputed with median	151	1.60	0.28
Ganyu nominal trend Afrint I to III, plus constant, logged	151	6.32	0.23
Started using conservation agriculture Afrint I to III, dummy	151	0.45	0.50
NPK trend Afrint I to III—pruned at 3SDs, plus constant, logged	151	7.44	0.22
Started using improved seeds between Afrint I and III, dummy	151	0.16	0.37
Started hiring in labour Afrint I to III, dummy	151	0.17	0.37
Distance to market, household level, logged, 2008	151	2.95	0.51
Distance to village centre, logged, 2013, missing values imputed	151	1.39	1.07
Trend in maize prices in USD nominal Afrint II to III, no outliers, plus constant, logged	151	2.84	0.20
Sex of farm manager consistent across Afrint II and III with Afrint I HH head, dummy	151	0.80	0.36

Maize Production in Malawi and Zambia, 2002–13

been imputed where appropriate, and skewness and kurtosis are below accepted limits. In this model, 151 units are available for the production function. Table 8.6 shows coefficients for the model alongside relevant further statistics. Collinearity statistics are within safe limits. The distribution of residuals is normal. Overall, the model explains a lower degree of variance than the Malawian model: only 22 per cent of the variance in maize yields.

Table 8.6 shows that similar to the Malawian model we find that fertilizer (0.30), distance to market (–0.20), and distance to the village centre (–0.19) show significance. However, and in contrast to Malawi, the coefficient signs for both spatial variables are negative, suggesting proximity to density and market channels is imparting a positive effect on yields. Moreover, we find

Table 8.6. Coefficients for Zambian production function

	Unstandardized coefficients		Standardized coefficients	Sig.
	B	Std. Error	Beta	
(Constant)	3.833	1.624		**
Age of head of household, years—square rooted, 9 missing values imputed with mean	0.014	0.035	0.032	
Years of schooling of farm manager—2013 variable logged, 6 values imputed with mean	–0.034	0.057	–0.047	
Estimate of trend in able workers Afrint I to III, plus constant, logged	0.269	0.121	0.174	**
Trend in maize area Afrint I to III, pruned at 3SDs, plus constant, logged, 7 missing values imputed with median	–0.040	0.133	–0.024	
Ganyu nominal trend Afrint I to III, plus constant, logged	–0.148	0.147	–0.075	
Started using conservation agriculture Afrint I to III, dummy	0.129	0.073	0.141	*
NPK trend Afrint I to III—pruned at 3SDs, plus constant, logged	0.618	0.168	0.303	***
Started using improved seeds between Afrint I and III, dummy	0.046	0.093	0.037	
Started hiring in labour Afrint I to III, dummy	0.094	0.092	0.076	
Distance to market, household level, logged, 2008	–0.129	0.071	–0.144	*
Distance to village centre, logged, 2013, missing values imputed	–0.075	0.034	–0.177	**
Trend in maize prices in USD nominal Afrint II to III, no outliers, plus constant, logged	0.077	0.170	0.034	
Sex of farm manager consistent across Afrint II and III with Afrint I household head, dummy	0.010	0.091	0.008	
	Model summary			
Model	<i>r</i>	<i>r</i> ²	Adjusted <i>r</i> ²	Std. error of the estimate
1	0.529a	0.280	0.211	0.40627

Notes: a. B is the symbol used for an unstandardized ordinary least squares regression coefficient.

two further variables that are influencing yields in Zambia: the trend in able workers (0.17) is significant at the 5 per cent level, and starting to use conservation agriculture (0.14) is significant at the 10 per cent level. In the same fashion as the Malawian model, the maize price variable and gender of farm manager show no significance.

Discussion of Results

For our discussion of the panel data results we draw on qualitative data collected in Malawi and Zambia in 2012 and again in Zambia in 2016. The production functions identified three independent variables as having a significant relationship with maize yields in both Malawi and Zambia: a positive relationship between fertilizer application and yields, and a relationship between distance to market/village centre and yields which is positive in Malawi (households further away from density/markets have greater yields) and negative in Zambia (households closest to density/markets have the greatest yields).

Despite the criticism that fertilizer subsidies have fostered, our data show that they have had an overall positive impact on maize yields, appearing to be the least-worst option for governments to support food security during an era of fluctuating global and national maize prices. In interviews, smallholders in both countries repeatedly and incisively return to describing households' fertilizer strategies. In Malawi poor soil fertility makes it imperative to apply appropriate amounts to achieve decent harvests. Smallholders rely almost exclusively on FISP, but when possible they buy additional unsubsidized fertilizers. Existing critique that the programmes create dependency and undercut the private market is confirmed. Village governments are in charge of distribution and as a rule they compel eligible households to share their bags of fertilizers, frequently causing respondents to complain that the amounts received are not sufficient. While FISP in Malawi is targeted to cater for the poorer households, the distribution principles for FISP in Zambia discriminate against those with less than 0.5 ha. Andersson Djurfeldt and Hillbom (2016) show how uneven access to subsidized fertilizers is part of an ongoing polarization process among Afrint households in Zambia. Smallholders depend on their memberships in cooperative unions for access; the more unions you join the more fertilizers you can access. While some cooperatives are active and members share multiple activities, others only exist for the distribution of FISP. The dependence on FISP and the programme's reoccurring late and unreliable distribution of fertilizers is a common complaint from respondents.

At first glance, the result from Malawi that households further away from markets and village centres have greater maize yields may not make intuitive sense. Taking into account the substantial subsistence production, variety of marketing opportunities, and alternative high-value crops, the result can, however, be explained. First, there are regional variations in the extent to which smallholders engage in the marketing of maize, many only growing maize for household consumption. Second, producers do not necessarily take their maize to the market themselves—they often prefer to sell to vendors at the farm gate thereby saving paying for transportation, costs that increase with distance. Furthermore, closeness to urban areas allows smallholders in densely populated Malawi to profit from the deepening of agricultural markets as they switch to high-value and more perishable crops such as vegetables, or provide for a growing ‘processing industry’, e.g. in the form of Irish potatoes or soya beans. Turning to the Zambian data, a different dynamic appears to be at work. While the FRA in many ways dominates the maize market and provides buying stations throughout the country, the parastatal’s inability to pay farmers on time entices many to switch to regionally and locally established grain companies, cooperatives, and private buyers. The closer smallholders are situated to markets the more likely they are to profit from increasing competition as well as keeping transportation costs down. Moreover, the much lower population density in Zambia means thinner local markets and limited opportunities for smallholders to switch into high-value food crops as is the case in Malawi.

Further, we have significant results that are country specific. The strong negative relationship between maize production and size of maize area in Malawi resonates with intensification and increasing land scarcity emphasized in key informant interviews. Age proved to have a significant negative relationship with maize yields in Malawi. This is an interesting observation as one often hears arguments about youth lacking interest in farming. Here we see that it is the younger households with stronger labour who are increasing productivity to a greater extent than their older peers. In Zambia we obtain a different result in regard to access to labour resources. Here increasing maize production is based on extensification processes, with more land being dedicated to maize farming, but the production function shows that it is not only land which plays a role in this growth process. Access to labour in the form of more able workers, i.e. more family members able to participate in farm work, also turns out to be important.

Furthermore, we have the positive relationship between practising conservation farming and increasing maize yields in Zambia. This is corroborated in the qualitative data where conservation farming, specifically ripping, is claimed to provide multiple and substantial benefits. As one progressive farmer near Mkushi explains, practising ripping, or deep tilling of only the

row where the crop will be planted, means that he no longer needs to plough and weed the whole field. Thereby he can farm a larger area compared to before without adding labour resources. Further, he can now plan his farming activities better, which reduces fluctuations in labour demand. Conservation farming practices have also increased his yields significantly. These claims are confirmed by the local agricultural extension officer.³

Before ending the discussion we need to comment on two insignificant results—prices and gender. We set up this study partly in the context of the recent commodity boom, and showed that national prices for white maize have experienced a rise (and fall) during the period of investigation in both countries. Subsequently, we hypothesized that rational smallholders would react by increasing their maize production, but this turned out not to be the case. What we can take from this result is that we should be careful when anticipating that smallholders living in remote areas in landlocked African countries will react to price incentives represented by global and national price levels. Finally, while households with female farm managers could not keep up with their male counterparts in terms of maize production they are sharing in the productivity increase, and their farming strategies are influenced by the same factors. This is a positive, and perhaps somewhat unexpected, result.

Concluding Remarks

In conclusion, a few results in our study are worth revisiting as they potentially carry policy implications. First, regarding existing agricultural policies it is clear that fertilizer subsidies have led to improved maize production. This conclusion does not contradict the critique that has been raised against fertilizer subsidy programmes, but the way forward would be to improve on the administration of existing programmes rather than to abandon them. Further, considering the success of conservation farming in both labour-saving farming methods and yields in Zambia, there may well be some scope for a systematic appraisal of conservation farming in Malawi. Third, while market prices offered by the FRA in Zambia have been beneficial for large-scale and emergent farmers, and contributed significantly to the growth in maize production, there are further market-enhancing reforms that remain to be

³ This partly contradicts the claims of the labour intensity of conservation farming also in Zambia as pointed to in Chapter 3. The explanation appears to lie in the type of conservation farming being practiced, where the construction of basins is more labour intensive than ripping, especially if the latter is not done by hand.

addressed. Development of physical infrastructure and improved spread of price information would greatly assist smallholders by lowering transaction costs for market participation. It would make farmers less dependent on middlemen and more directly involved in markets, thereby more likely to profit from any future price hikes. Finally, considering their lower asset holdings, the ability of female farm managers in both countries, and younger households in Malawi, to share in broad productivity increases demonstrates how maize and food security policy should not marginalize such households.