IMPACTS OF GOVERNMENT MAIZE SUPPORTS ON SMALLHOLDER COTTON PRODUCTION IN ZAMBIA

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ABSTRACT

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In Zambia, cotton has been an agricultural success story led by private cotton ginneries and smallholder production. Since liberalization in 1994, the cotton sector has seen periods of dramatic growth and two severe crashes. Production recovered well after the crash in 2000, but recovery since 2007 has not been as strong.

The Zambian government has drastically increased its supports to smallholder production of maize since the 2005 harvest year through maize purchases by the Food Reserve Agency (FRA) and subsidized fertilizer targeted to maize through the Farmer Input Support Program (FISP). Because cotton is almost entirely produced in the country's main "maize belt", these maize supports in principle also affect the relative profitability of cotton, but any effects directly on smallholder cotton cropping decisions are largely unknown.

This thesis attempts to move towards understanding the effects of the FRA and FISP maize supports on smallholder cotton production in Zambia. Two separate Cragg hurdle models are employed to determine the effects of the maize supports on i) smallholders' decisions whether to plant cotton, and ii) their land allocation decisions to cotton given that they decided to plant it. We also track household cotton planting decisions over a ten year period and analyze across several household indicators.

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LIST OF ABBREVIATIONS

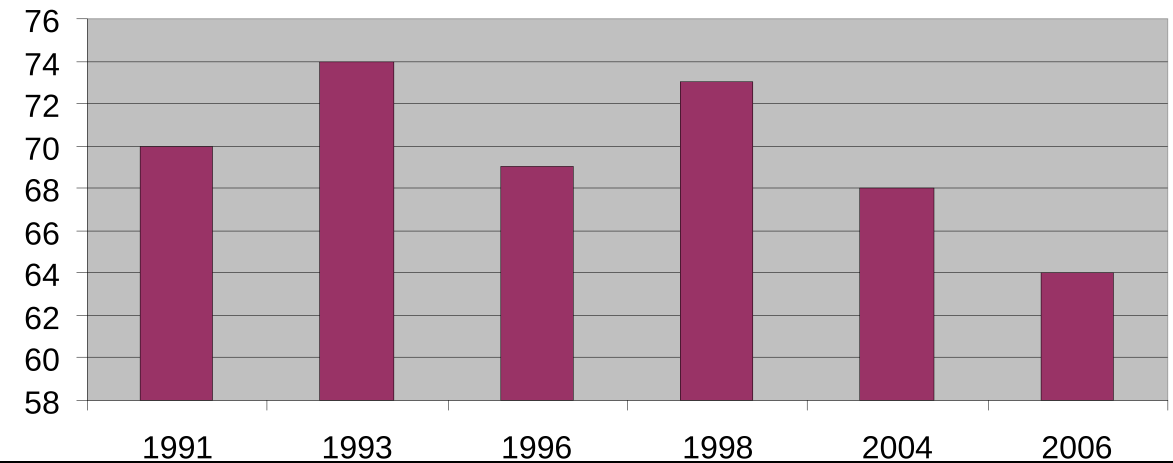
AEZ	Agro-Ecological Zone
AMIC	Agricultural Market Information Center
APE	Average Partial Effect
ATC	Authority to Collect
CMB	Cotton Marketing Board
CRE	Correlated Random Effects
CSO	Central Statistical Office (Zambia)
C4	Cotton Four
DAC	District Agricultural Committee
ESA	East and Southern Africa
FISP	Farmer Input Support Program
FRA	Food Reserve Agency
FSRP	Food Security Research Projects
ha	hectare(s)
HH	Household
HHH	Household Head
kg	kilogram(s)
mt	metric ton(s)
MACO	Ministry of Agriculture and Cooperatives
PCO	Program Coordination Office
PHS	Post Harvest Survey
SEA	Standard Enumeration Area
SS	Supplemental Survey
SS01	Supplemental Survey 2001
SS04	Supplemental Survey 2004
SS08	Supplemental Survey 2008
SSA	Sub-Saharan Africa
US	United States
WCA	West and Central Africa

1. INTRODUCTION

1.1 Background Information on Zambia

Zambia is one of the poorest countries in the world by several measures. According to Zambia's Central Statistical Office (CSO), 64% of households were living below the country's poverty threshold in 2006 (Figure 1.1), down from a peak of 73% in 1998. According to CSO, most of this recent decline can be attributed to rural areas where the incidence of poverty decreased from 88% in 1991 to 78% in 2006.

Figure 1.1: Zambian national poverty rates



For interpretation of the references to color in this and all other figures, readers are referred to the electronic version of this thesis.

Source: Zambia Central Statistical Office (CSO), Living Conditions Monitoring Surveys

While the recent decline in rural poverty is encouraging, 78% of rural households living in poverty is a striking number and in terms of per capita income Zambia was still ranked in the bottom thirty countries in the world (CIA, 2010). While contemporary poverty definitions extend beyond incomes and into health factors, water access and other measures, this study focuses on incomes and their direct contributions to household food security.

Most of these rural and impoverished people can be classified as smallholder farmers; that is, a large portion of their economic activity involves farming small areas of land, typically not larger than 2 hectares (about 5 acres). About 65% of Zambia's population was rural in 2005 (UN, 2009). These smallholder households, in order to meet their daily caloric consumption needs, must either harvest enough food from their own production or secure enough cash income throughout the year to consistently purchase food; most smallholder households obtain food in both ways. Some 57% of these households earned income from crop sales following the 2007 harvest (SS08), and others earned income by working on nearby farms for wages; so many rural households depend on agriculture both for their own food consumption and for their cash income. In Zambia, as in most of Sub-Saharan Africa (SSA), rural poverty, food security and agricultural productivity are inextricably linked.

1.2 The Importance of Cotton

Africa as a whole has been losing ground with the rest of the world in agricultural productivity and trade. According to Tschirley et al (2009), from 1980 to 2005, Africa's share of total world agricultural trade dropped by about half. But hidden within this dire agricultural picture is a promising success: cotton. Over the same period when Africa's share of total agricultural trade was falling, the continent's share of cotton trade more than doubled as SSA cotton production grew three times faster than in the rest of the world.

1.2.1 Outgrower Schemes

Nearly all of the cotton production in SSA is done by smallholder farmers, making the increasing cotton production in SSA a success for the rural poor. Growing cotton requires quality seed and pesticide inputs, and very few Zambian smallholder farmers have enough cash in November (the typical planting time) to purchase from a dealer outright. Furthermore, as in nearly all of Africa, underdeveloped rural credit markets mean that smallholder farmers have almost no access to seasonal credit to finance input purchases. If smallholder farmers were forced to purchase their own inputs, few farmers would have the assets and income required to plant cotton. The high input costs would place cotton outside many households' choice set of crops to plant.

Outgrower schemes typically channel the inputs from a processor to the smallholders prior to planting in return for the processor's right to purchase all of the crop output after harvest (often at a preset price) less the value of the inputs supplied earlier in the year. Essentially, the inputs are provided on loan at planting time and the loan is paid off when the crop is sold. Government involvement in the execution of the outgrower scheme and in the provision of inputs has varied by country and over time. For instance, some West and Central Africa (WCA) countries continue to utilize government managed parastatals while Zambia and most other countries in East and southern Africa (ESA) provide minimal government support, relying almost entirely on private cotton ginneries to provide inputs.

A persistent problem with many outgrower schemes has been the ability to recover the value of the input loans and prevent side-selling (selling to a buyer that did not provide input credit to the farmer) of the output. Parastatal monopolies in WCA have done a good job of preventing side-selling, but Zambia's private led scheme has been susceptible to the problem. The outgrower scheme's success depends in large part on its ability to mitigate side-selling while promoting increased productivity and total production.

1.2.2 The “Cotton-4” Example

Among SSA’s cotton producing countries the “Cotton-4” (C4) in WCA has received almost all of the attention. The C4 consists of Mali, Benin, Burkina Faso and Chad; three of these countries (Mali, Benin and Burkina Faso) led SSA in cotton production from 2004 to 2008. The government managed parastatal cotton companies in the C4, enjoying near monopolies on ginning capacity and thus almost entirely able to control the side-selling problem, had used cotton production over many years as a means of spurring rural development[1]. Also, with their increased cash incomes from cotton sales, rural cotton farmers were able to invest in agricultural assets like better tools and animal traction which increased their yields and productivity in cotton and other crops as well. A well-functioning cotton sector can increase smallholder incomes, and, as shown by the example set in WCA, it can also contribute to reaching broader rural development goals that benefit all rural farmers, including those who do not grow cotton.

The government led systems in WCA showed signs of weakness in the mid-1980s through early 1990s as the cotton sectors saw stagnant production volumes and financial problems engendered by high sector costs. The sectors have also experienced problems with parastatal management that have led to increased inefficiencies (Tschirley et al, 2009). Despite these difficulties, the C4 countries, and WCA as a whole, proved that a well-functioning cotton sector can lead to effective rural development.

1.2.3 Zambian Cotton Production

While WCA’s cotton production stagnated in the early 1990s, Zambia implemented more liberalized agricultural policies and opened up its cotton sector to competition. Over the next

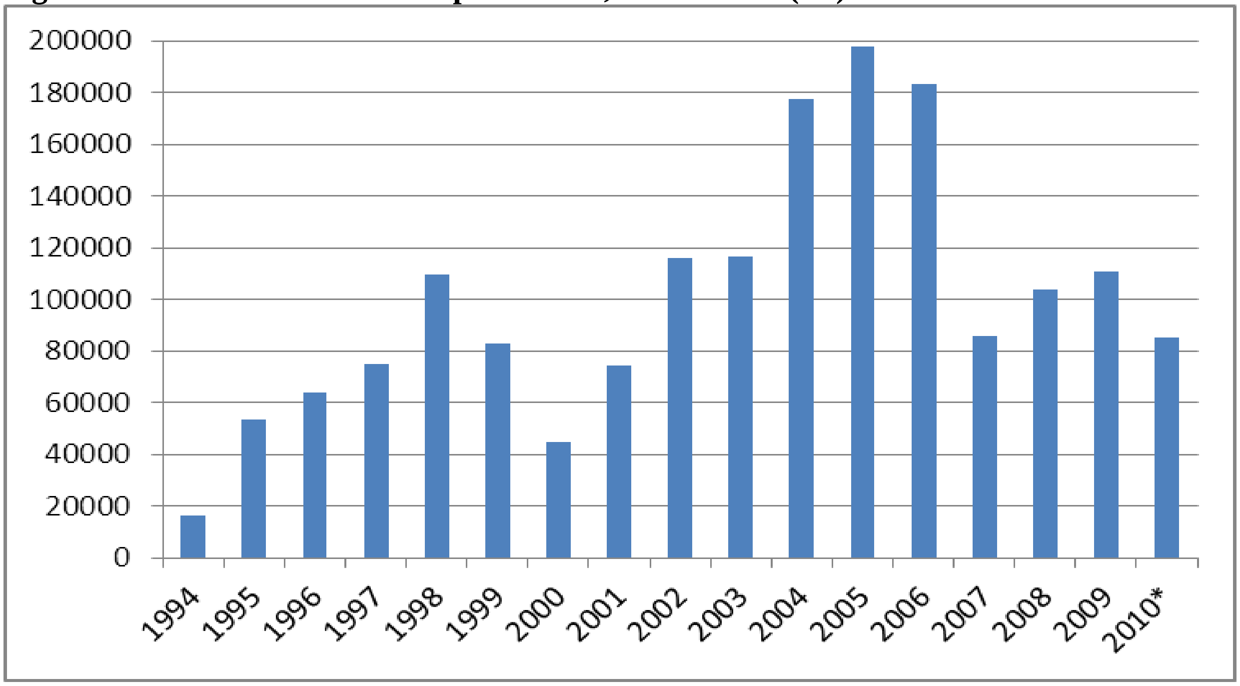
[1] Note that Burkina Faso allowed limited private entry in 2006 but had a single monopoly prior to that time.

decade, cotton's importance among agricultural commodities in Zambia grew significantly: nationwide output grew by over 1,000% in only eleven years (Figure 1.2).

The development of the cotton industry in Zambia has the potential to increase rural smallholder incomes and improve household food security for some farmers. Tschirley and Kabwe (2007) found that the returns to a day's labor in cotton production for small plots of land was well above the rural wage rate in Zambia for the 2004/05 and 2006/07 cropping seasons. Furthermore, Govereh and Jayne (2003) found evidence in Zimbabwe that producing cotton brought benefits beyond increased incomes from crop sales in two main ways. First, the study found that cotton producers are able to obtain skills and key inputs that increase their productivity in other crops as well as cotton. Second, the study found that the presence of cash cropping and specifically cotton production brought increased investment to the region that benefited all farmers. Thus, cotton production can increase smallholder incomes and overall farming productivity among growers and act as a catalyst for rural development.

National cotton production in Zambia has seen two periods of dramatic growth since 1994. As shown in Figure 1.2, both of these growth periods – 1994 to 1998 and 2000 to 2005 – saw aggregate seed cotton production volumes more than triple. While the overall story since 1994 is one of large and promising growth, the sector has faced several challenges that have contributed to production crashes in the 2000 and 2007 harvest years. These crashes and production instabilities are pressing concerns for Zambia's cotton sector.

Figure 1.2: Zambian seed cotton production, 1994 – 2010 (mt)



* denotes forecast prediction of production
Source: Cotton ginnery throughput estimates

Causes of each crash can be categorized as internal or external to the sector. Internal sources of instability primarily include issues related to the outgrower scheme. The success of the outgrower scheme is directly related to cotton ginneries' ability to prevent side-selling of cotton output and recoup the value of the loaned inputs. As a result of increased farmer frustrations with decreasing cotton prices, poor transparency in price by cotton ginning companies, and widespread side-selling, which peaked during the 1998/99 growing season, rates of credit default among smallholder cotton growers increased. This led cotton ginneries to scale back the number of farmers that they contracted with and production collapsed in the 2000 harvest year (Govereh et al, 2000).

One external source of instability was the considerable appreciation of the Zambian kwacha (ZMK) relative to the US dollar that occurred from late 2005, just after cotton planting, into mid-2006, when cotton was being purchased, processed, and readied for export. This relative rise in currency value harmed Zambia's exports including cotton. Cotton ginneries were forced to lower their prices paid to farmers for the 2006 harvest and repayment rates dropped causing another production crash in the 2006/07 season. Another potential external challenge to cotton production involves the Zambian government's heavy emphasis on promoting domestic maize production.

1.3 Maize Supports

While cotton has been somewhat neglected by policy makers, one agricultural commodity that has received no shortage of attention from the Zambian government is maize. Maize is the dietary staple in most of East and Southern Africa (ESA), and it is eaten at least once daily by nearly all Zambians. As a result of their people's strong preferences for maize, the agricultural policies of most ESA countries can be described as maize-centric. Zambia has recently proven its maize preferences by dramatically increasing its supports to maize production since the 2005 harvest season.

The two largest support programs are government purchases of maize through the Food Reserve Agency (FRA), typically at prices above the market price, and subsidized maize seed and fertilizer through the Farmer Input Support Program (FISP) – formerly the Fertilizer Support Program (FSP). Both programs are large and costly: the FISP consistently accounts for about 35-40% of Zambia's agricultural budget annually (Xu et al, 2009).

The FRA purchases several agricultural commodities each year, but the scale of their maize purchases dwarfs those of other commodities. The FRA purchased 390,000 metric tons of maize in the 2007 harvest year, which was over 30% of estimated smallholder maize production (PHS). In the 2008 harvest year, maize accounted for 98% of all planned FRA purchases. The

FRA purchases maize at an above market price and attempts to reach into areas with limited market access to buy from rural smallholders. The FISP tries to supply fertilizer and quality maize seed to smallholder farmers who would not otherwise be able to afford it, the idea being that increased maize production from fertilizer use would significantly contribute to household and national food security. Fertilizer subsidies affect maize production heavily because Zambian smallholders apply fertilizer almost exclusively to maize fields: in the 2006/07 growing season, over 90% of the fertilizer applied by smallholders went into maize fields (SS08).

1.4 Potentially Problematic Relationship between Cotton Production and Maize Supports

Unfortunately, the maize supports do not always have their expected positive results. For instance, there is evidence that FISP fertilizer often does not reach its intended beneficiaries, being sold off to wealthier smallholder farmers (see chapter 3). Furthermore, Xu et al (2009) concluded that FISP fertilizer quantities received in areas with already strong fertilizer markets actually decrease the amount of fertilizer used in the area. Meanwhile, the execution of FRA maize purchases in rural areas can be very expensive and diverts funds and efforts away from other programs.

While these unintended effects are fairly straightforward, there is perhaps another unintended consequence of Zambia's maize supports that is hidden from first glance. The FRA and FISP maize supports to smallholder farmers have the combined effect of increasing the profitability of maize production and they make maize relatively more appealing compared to other crop options. The hybrid seed varieties provided by FISP are more responsive to fertilizer than cotton and other crop options for Zambian smallholders, and it is widely understood that fertilizer is predominantly applied to maize. Thus, when a household is faced with their decisions at planting time of what area to devote to maize, if said household expects to receive FISP fertilizer and hybrid seed or expects to be able to sell their maize output to the FRA at the higher price, then, ceteris paribus, they will most likely plant maize in a larger area than they otherwise would. This potentially increased maize area may come at the cost of lower areas planted in other crops. Crawford et al (2006) refer to this potential problem as it specifically relates to fertilizer promotion programs as an "inefficient substitution of crops towards those that use the subsidized fertilizer." In Zambia, maize supports go well beyond fertilizer promotion, and could potentially magnify this problem.

This opportunity cost is relevant to the once booming cotton sector as nearly all cotton is produced in Zambia's maize belt. It is possible that maize competes with cotton for smallholders' land areas, and, in some cases, the maize supports may contribute to farmers electing to plant more maize and less cotton. Thus, the strong government maize supports may be inadvertently damaging Zambia's private sector agricultural success, cotton, by luring farmers away from cotton production and into increased maize production.

1.5 Purpose of the Study

The overall purpose of this research is to determine what the effects of the aforementioned FRA and FISP maize supports are on the private cotton sector. The paper has three specific objectives: i) identify what characteristics drive smallholder decisions to plant cotton, ii) evaluate the effects of FRA and FISP supports on smallholders' decisions to plant cotton or not, and iii) evaluate how the same programs affect areas planted in cotton among cotton growers.

If the Zambian government is going to continue promoting maize production among smallholder farmers, it is important that they have an understanding of the full costs of the policies. Such costs would include any adverse effects on the production of other crops; and the effects felt by the cotton sector, with its potential to increase smallholder incomes, are of particular importance.

We meet the above mentioned objectives through quantitative descriptive analysis and empirical estimation of econometric models on panel data. The main strength of our econometric approach is that we study the proposed problems with two different models applied to two independent data sets: two separate Cragg hurdle models (1971) are used in this study. The first model uses two years of a household level panel data set and employs a correlated random effects (CRE) Cragg model. The second model uses two years of a household survey that is a panel at the standard enumeration area (SEA) level, and applies a SEA level fixed effects Cragg model to these data. A full discussion of our two approaches can be found in Chapter 4.

1.6 Organization of the Study

This paper is organized in five chapters. Following this introduction, Chapter 2 analyzes Zambia's cotton sector in detail. It begins by looking at the spatial distribution of cotton production and continues by expanding upon the sector's structure and the evolution of production over time. It then tracks a sample of smallholder farmers and their production decisions over a ten year period and characterizes them across several household indicators. The chapter concludes with a summary of key findings.

Chapter 3 discusses operational structures of the Zambian government's major maize support programs, the FRA and the FISP. It then examines the spatial distribution of these supports along with maize production and it characterizes the households participating in these support programs by several household indicators. The chapter continues with an assessment of the effects of maize supports on farmers' maize cropping decisions, and concludes with a brief summary of findings.

Chapter 4 explains the conceptual model used in the study and provides technical details on the Cragg hurdle model and its properties. It also discusses both of our econometric techniques in detail and describes the data that each uses. The results of each model are then presented and explained. Chapter 5 summarizes this paper's key findings and concludes with a discussion of implications for Zambia's agricultural policies.

2. ZAMBIAN COTTON SECTOR

2.1 Introduction

This chapter discusses Zambian cotton production in detail. It begins by showing the spatial distribution of cotton production across Zambia's four Agro-ecological Zones (AEZ). Next, the chapter continues the discussion on Zambia's cotton sector structure found in the introduction to this paper and provides more detailed information on the sector's formation. Then it evaluates cotton production over time focusing specifically on production trends and instabilities. It concludes by summarizing key findings in the data analysis of cotton production and smallholder cotton producers.

We use data from several sources in this chapter. The Post Harvest Survey (PHS) is an annual survey of more than 6,300 smallholder farmers executed after the growing season by Zambia's Central Statistical Office (CSO). We take weighted annual cotton production estimates from these data sets for the years 1993 through 2007. All years listed in this chapter are harvest years and signify the year in which the growing season ended and crops were harvested. We also use ginner estimates of cotton production as a cross reference against the PHS data. The two production estimates show the same trends and tell the same story of year-to-year production changes, but the ginner estimates are consistently larger than the PHS estimates. We take the ginner production estimates to be the most accurate for aggregate production and we use these data for discussion on total production levels. Because ginner estimates are difficult to allocate over space, we use the PHS data to discuss the spatial distribution of cotton production, including the percentage of smallholder farmers growing cotton.

We also use a three year panel data set collected by CSO in cooperation with the Food Security Research Project (FSRP). The panel data questionnaires were given as a "Supplemental

Survey" to the PHS and were implemented in 2001 (SS01), 2004 (SS04) and 2008 (SS08), after attrition, 4,340 households were interviewed during each of these three years. The 2001 questionnaire retrieves information on households planting cotton for the harvest years 1998, 1999, 2000, and 2001: the 2004 questionnaire retrieves cotton planting information for 2002, 2003 and 2004: and the 2008 survey retrieves the same information for 2005, 2006 and 2007 harvest years. Together, these data make it possible to track 1,985 smallholder households in Eastern, Southern and Central provinces and whether or not they planted cotton each year from the 1998 harvest season through the 2007 harvest season. We use the panel data to analyze movement of specific households into and out-of cotton production across this ten year period and to characterize and compare the households that have steadily produced cotton over the years and the households that have not. We use both the panel data and the PHS data to discuss the agronomic practices employed by cotton farmers.

2.2 Spatial Distribution of Production

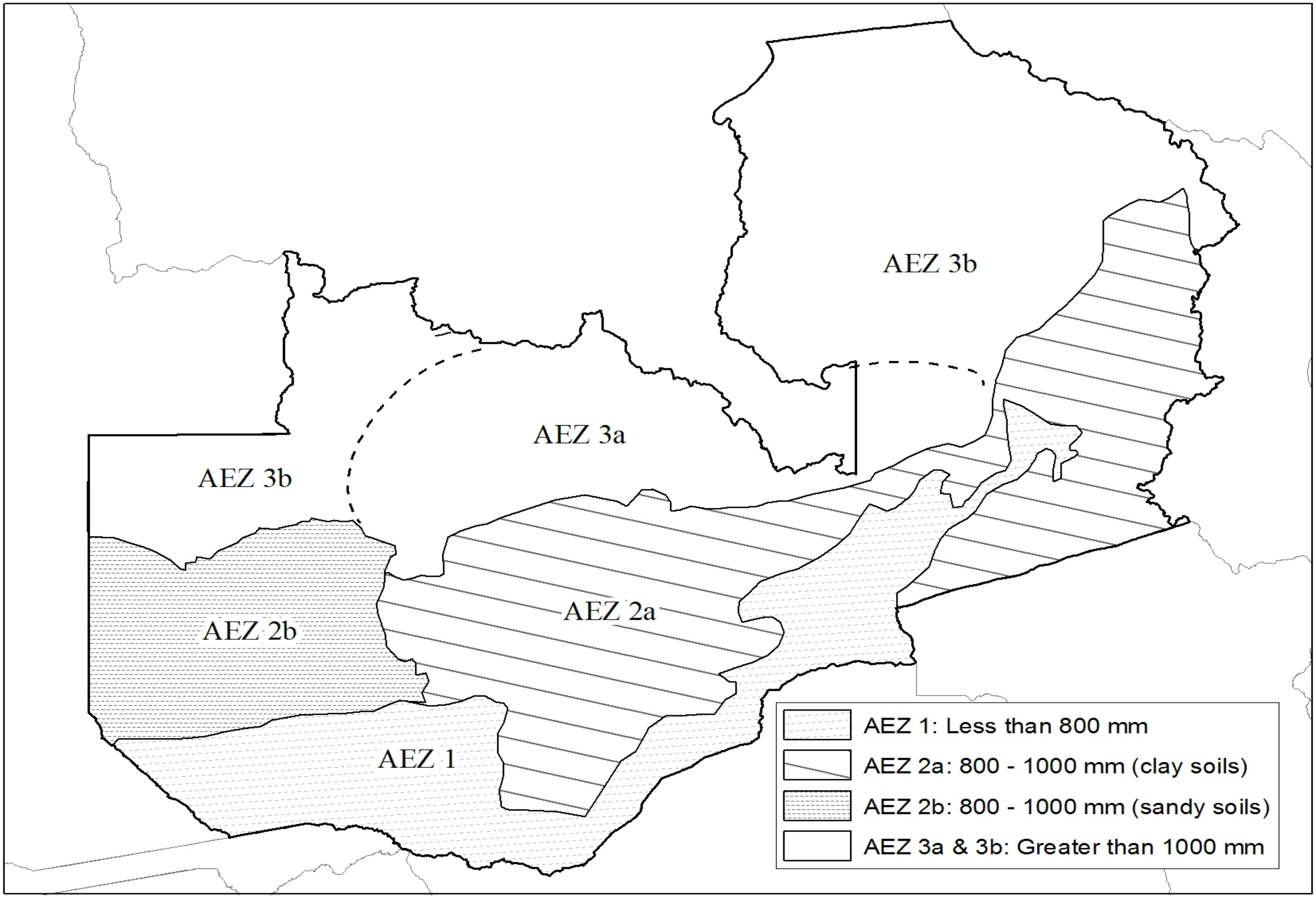
To understand Zambia's cotton sector, it is useful to begin with a quick overview of the agronomic practices employed by cotton farmers. Cotton is grown in pure stands and is most frequently rotated with maize, although there are some fields in continuous cotton and others rotated with groundnuts. Smallholders apply almost no fertilizer or manure to their cotton fields; however cotton fields require additional attention and inputs in other ways. Over the growing season, cotton fields are weeded once more than maize fields on average. Additionally, cotton plants need to be sprayed with pesticides to control pests including aphids and Lepidoptera species. In 2006, cotton production required an estimated 110 days of labor while maize required only 90 days (Tschirley and Kabwe, 2007). Despite the high labor costs of cotton relative to maize, a good cotton yield can be highly profitable for a smallholder household.

A successful cotton yield requires fertile soils with the correct amount of water – not too much, but not too little – quality inputs – seeds and pesticides – and proper care during germination and growth. Households obtain the quality inputs and extension advice on farming practices through contract farming, which is discussed in the introductory chapter. In Zambia, rainfall quantities and soil types limit where cotton is grown. Cotton is bred to be drought tolerant and excess water and flooding damages the crop. Also, clay soils are better than sandy soils for cotton production.

Figure 2.1 shows Zambia's AEZs. AEZ 1 and AEZ 2a are ideal for cotton production. AEZ 1 receives the right amount of rainfall to sustain drought tolerant cotton. AEZ 2a receives slightly more rainfall, but has clay soils which support cotton particularly well. AEZ 2b has the same annual rainfall as AEZ 2a, but has sandy soils that are poor for cotton production. AEZ 3 receives too much rainfall to support healthy cotton production although cotton is grown in some of the lower rainfall areas of the zone. The Central, Eastern, and Southern provinces make up most of AEZs 1 and 2a. It is no surprise, then, that these three provinces have accounted for more than 95% of the cotton production in Zambia annually since 1993 (PHS).

Table 2.1 shows the percentage of smallholder households planting cotton and the share of nationwide cotton production for each province. In 2007, cotton was grown by only 10.8% of Zambian smallholder farmers, but in the three main cotton growing provinces, 23.1% of smallholders grew cotton and accounted for about 98% of all the cotton farmers in the country.

Figure 2.1: Zambia's agro-ecological zones



Source: Reprinted from Nielson (2009)

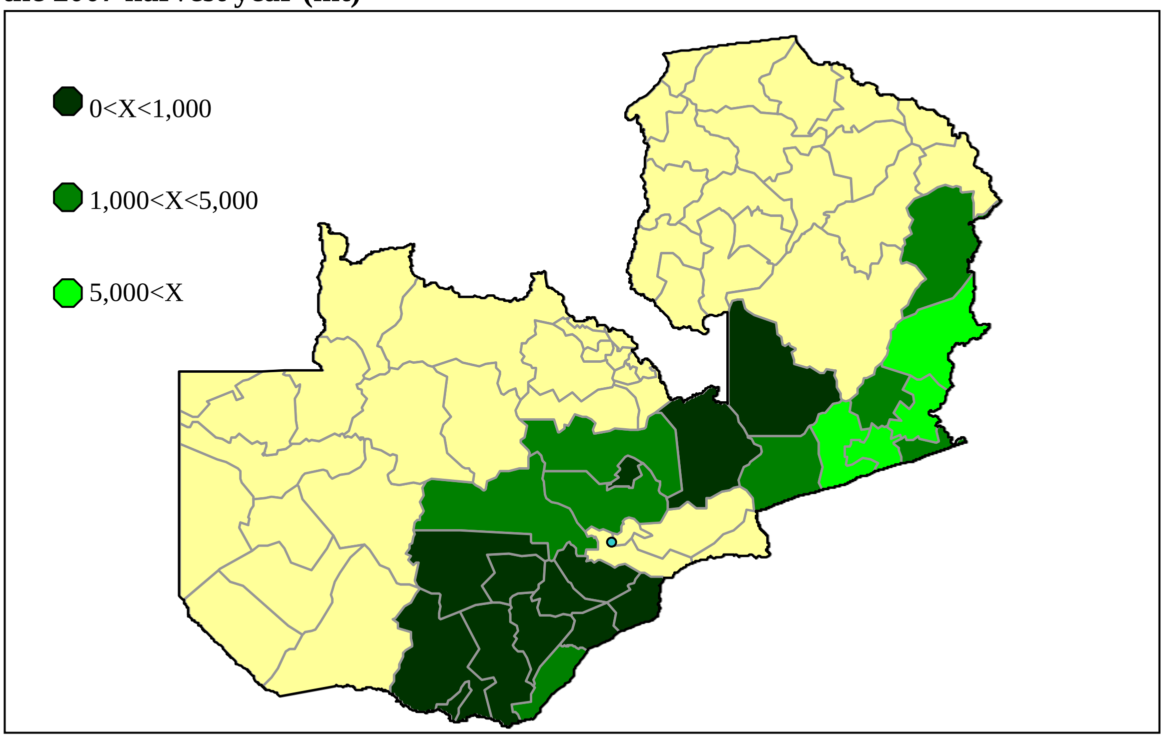
Table 2.2: Share of cotton production and % of households that planted cotton in each province

		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Eastern Province	Production % of Total	66%	60%	62%	63%	65%	64%	67%	60%	63%	79%
	% Growing Cotton	31%	29%	19%	31%	38%	28%	42%	51%	43%	34%
Central Province	Production % of Total	23%	27%	32%	27%	23%	24%	20%	24%	23%	10%
	% Growing Cotton	18%	16%	7%	11%	17%	18%	21%	27%	26%	7%
Southern Province	Production % of Total	9%	11%	5%	9%	10%	10%	11%	15%	13%	11%
	% Growing Cotton	7%	9%	3%	7%	12%	9%	12%	18%	18%	6%
Lusaka Province	Production % of Total	1%	2%	0%	1%	2%	1%	2%	1%	1%	1%
	% Growing Cotton	3%	4%	0%	5%	7%	1%	6%	7%	4%	1%
Western Province	Production % of Total	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	% Growing Cotton	1%	1%	0%	0%	0%	0%	1%	1%	1%	0%
Copperbelt Province	Production % of Total	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	% Growing Cotton	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Northwestern Province	Production % of Total	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	% Growing Cotton	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Northern Province	Production % of Total	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	% Growing Cotton	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Luapula Province	Production % of Total	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	% Growing Cotton	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Source: Author's calculations from PHS data

Eastern province is the definite leader in cotton production. About 34% of smallholders in Eastern province grew cotton in the 2007 harvest season and produced 44,700 metric tons, which was over 78% of the national production for the season. Southern province ranked a distant second in production in 2007 with about 6,100 metric tons of cotton produced by 5.8% of its smallholder households. Central province ranked a close third with 5,530 metric tons produced and 7.3% of its smallholder households growing cotton. The remaining six provinces accounted for less than one percent of Zambia's total cotton production in 2007.

Figure 2.2: Cotton production by district in Central, Eastern and Southern provinces for the 2007 harvest year (mt)



Source: Author's calculations from PHS data

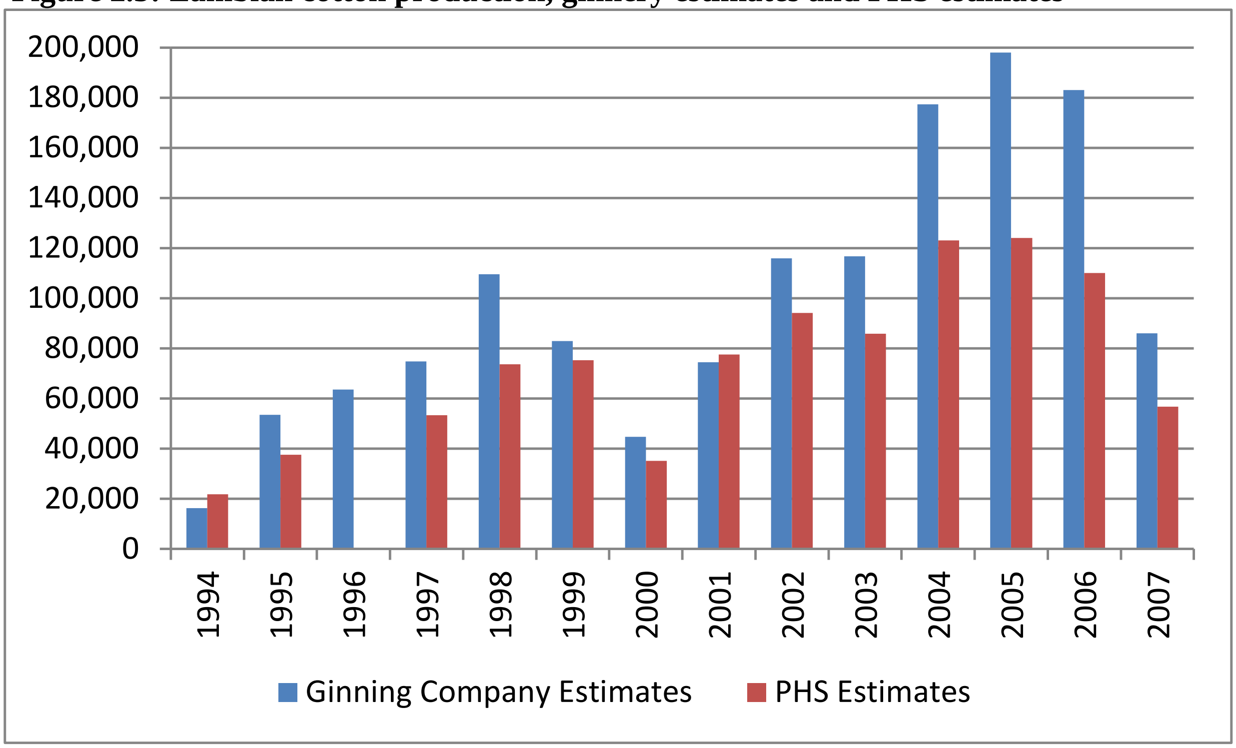
Figure 2.2 shows the distribution of cotton production across districts in Eastern, Central and Southern provinces. Eastern province has the five largest cotton producing districts in the country and has no districts that produced less than 1,000 metric tons of seed cotton. Central province has two districts with zero cotton output and three districts that produced greater than 1,000 metric tons. Nearly all of the districts in Southern province produced less than 1,000 metric tons of seed cotton, with only one district (Sinazongwe) above that production range.

2.3 Cotton Sector Evolution since Liberalization

In addition to the proper amount of rainfall and the right soil type, smallholders need quality cotton seeds and pesticides to grow cotton. These inputs are often too expensive for farmers with limited cash income and no access to seasonal credit. The solution to this problem has been the outgrower scheme, which is discussed in detail in the introductory chapter. This outgrower scheme and Zambia's evolving cotton sector structure has worked well at times, but twice since 1994 the lack of regulation has allowed small cotton companies to enter the market and promote side-selling of cotton output contributing to a collapse in nationwide cotton production. These collapses are seen in years 2000 and 2007 in Figure 2.3, which displays cotton production volumes in metric tons for harvest seasons 1994 through 2008, the last year for which we have data. The chart shows the overall story of strong growth and unprecedented production increases, but with some instability and two crashes. Zambian cotton production quantities are inextricably linked to the success of the outgrower scheme and the overall structure of the sector.

This structure has changed considerably in the past twenty-five years. Cotton production in Zambia was initially controlled by Lint Company of Zambia (LINTCO) – a parastatal monopoly started in 1977. Because of cotton's input intensity, government involvement was deemed necessary to purchase and distribute the inputs to smallholders in the absence of a well-functioning credit market. LINTCO also provided extension advice and purchased the cotton from farmers, recovering the credit at the time of sale. In 1994, reflecting a shift towards a more liberalized agricultural policy, LINTCO's assets were sold to two private cotton ginning companies: Lonrho Cotton and Clark Cotton. The parastatal LINTCO was split geographically in a way that was intended to minimize competition between the two private firms. Lonrho took over operations in Central and Southern provinces. Clark took over the Eastern province operations.

Figure 2.3: Zambian cotton production, ginnery estimates and PHS estimates



* denotes forecast prediction of production
Source: Author's calculations from PHS data and Cotton Ginning Company survey

The cotton sector remained in this form, a duopoly with minimal competition between Lonrho and Clark and little competition with small, independent cotton buyers, until 1997. Over this period, the two Zambian cotton firms steadily increased their outreach and cotton throughput. National production rose steadily from less than 20,000 metric tons of cotton in 1994 to more than 100,000 metric tons in 1998. At this time there was almost no formal regulation of the cotton sector. Soon, however, the low barriers to entry allowed several new cotton buyers to enter the market and begin competing with Lonrho and Clark. Although these competitors were much smaller than Lonrho and Clark, their effects on the unregulated sector were severe. Smaller cotton buyers were not committed to the same quality extension services that Lonrho and Clark were and, more importantly, they often competed by undercutting the other companies' contracts with farmers. The smaller cotton companies, because they did not provide inputs to the farmers on loan and so they did not have to recover these costs, could offer cotton farmers a higher price than Lonrho and Clark. The presence of more buyers offering higher prices led to widespread "side-selling", in which farmers sold to these smaller buyers and did not repay their loans to Lonrho and Clark, resulting in large losses for these companies. Repayment rates plunged after 1998 and, as a direct result, cotton companies scaled back their operations and contracted with fewer farmers. Cotton production fell by over 50% to less than 50,000 metric tons in 2000. The outgrower scheme's first failure contributed to Lonrho's decision to leave Zambia and sell its assets to Dunavant in 2000. At least one of the newer ginning companies was harmed as well, but managed to stay in the market (Tschirley and Kabwe, 2007).

The remaining cotton companies rededicated themselves to loan recovery and innovated ways to insure that contracts were honored. Dunavant and Clark, still the sector's dominant companies, began again to work with larger numbers of smallholder farmers and cotton production recovered steadily. Trust in the outgrower scheme was renewed and cotton companies ramped up their contracts.

As fast as aggregate production had dropped in 1999 and 2000, it grew even faster in the two years following the crash. Production increased by greater than 50% in both 2001 and 2002 and production totals quickly surpassed their pre-crash levels. The Zambian government – which had been inactive in the cotton sector for over a decade – began to take an interest in cotton production.

A new administration took power after elections in 2002, and began to design policy initiatives for a range of cash crops, including cotton. The Cotton Outgrower Credit Fund (COCF) was the first government involvement in the cotton sector since liberalization in 1994. The COCF was created to secure government funding of credit to cotton farmers through the ginning companies. The government wisely allowed the cotton companies to freely allocate the funds they receive through COCF, which has had the effect of reducing their borrowing costs. The COCF remained small – distributing just 340,000 USD in 2005 – but the smaller ginning companies benefited most from the funding as it allowed them to increase their outreach area considerably. One criticism of the COCF has been that it has not made all cotton ginneries adhere to its rules. More specifically, the COCF has not adequately punished cotton ginneries that do not submit open records of their contracts and transactions to COCF managers.[2]

In 2003, production stagnated at about 115,000 metric tons; but in 2004, production grew again to around 180,000 tons. The next season, cotton production peaked at an all-time high of greater than 190,000 tons – almost five times the tonnage of seed cotton produced just five seasons earlier. Meanwhile, the government advanced its involvement in the cotton sector in 2005 when it passed the Cotton Act, which laid out the framework for a Cotton Marketing Board (CMB) to police the cotton sector. The CMB consists of appointed government officials and private sector representatives, and its main purpose is to oversee the cotton sector and to reduce side selling by policing the farmers and companies to make sure that contracts are honored.

[2] This paragraph draws from Tschirley and Kabwe, 2007.

The tremendous five year growth streak ended after the 2005 harvest. In late 2005 a rapid appreciation of the Zambian kwacha relative to the US dollar hurt Zambia's export sectors, including cotton. The appreciation was not predicted by cotton companies and, because it happened quickly over the 2005/06 growing season, Dunavant, for the first time in its history, did not honor its pre-planting minimum price with farmers. Dunavant paid farmers a lower price for their seed cotton than they announced at planting time. Cotton farmers were upset by Dunavant's failure to honor their announced price and repayment rates dropped again following the 2006 harvest. Production fell slightly in 2006, but the low repayment rates made the cotton ginning companies reduce their number of contracts for 2007 and production dropped even more dramatically. For the first time since 2001, smallholders harvested less than 100,000 metric tons of seed cotton as production fell by nearly 50% in 2007.

The sector was in transition throughout this second crash. In 2006, Clark Cotton sold their assets in Zambia to Cargill Cotton, a multinational corporation with operations worldwide. Also, cotton ginners and farmers suggested several revisions to the Cotton Act and the newer cotton companies increased their throughput.

Table 2.2 shows that Dunavant had the greatest capacities and the highest throughput for the 2004, 2005 and 2006 harvest years. Cargill was a distant second with volumes less than half of Dunavant's. The newer cotton ginners were increasing their throughput over the same timeframe, but were still small compared to Dunavant and Cargill, with combined ginning capacity equal to only 28% of the total. The other seven cotton ginning companies listed in Table 2.2 (Great Lakes, Alliance Cotton, Continental, Mulungushi, Chipata-China-Cotton Ginnery, Mukuba and Birchland Oil Mills) combined for just under 11,000 metric tons of throughput in 2004 – many of the companies were inactive. In 2006, the same companies combined for over 43,000 metric tons of throughput. Today the sector is substantially more competitive than in previous years, but still quite concentrated, given that Dunavant and Cargill had about 80% of the market in 2006.

Table 2.3: Cotton ginnery capacities and throughputs, harvest years 2004/06

		Seed Cotton Throughput (harvest years)		
Company	Capacity (MT/Season)	2004	2005	2006
Dunavant	> 115,000	112,500	131,300	112,000
Cargill	60,000	48,976	44,196	42,023
Great Lakes	10,000	0	0	10,000
Alliance Cotton	No data	0	0	8,000
Continental	25,000	5,000	7,000	8,000
Mulungushi	10,000	5,820	8,314	5,140
Chipata-China Cotton Ginnery	15,000	0	No data	12,000
Mukuba	500	43	113	24
Birchand Oil Mills	0	0	0	No data
Total	>215,000	172,339	190,923	197,187

Source: Tschirley and Kabwe, 2007

After the second production collapse, the sector showed signs of a rebound in 2008 as cotton production increased to around 100,000 metric tons. However, cotton harvest estimates for the 2009 and 2010 harvests were 110,000 metric tons and 120,000 metric tons respectively. The recent recoveries in aggregate cotton production have been modest relative to the recovery following the first sector crash. Part of the difference in the sector recoveries may be due to the fact that situations and conditions presented to farmers and cotton ginning companies have changed in recent years. One such change has been the recent increases in government led supports to smallholder farmers for maize production – discussed in detail in the next chapter.

The future status of Zambia's cotton sector remains uncertain. It has shown some damaging instability with the two production crashes, but we can safely say that Zambian cotton production has been a strong example of private led agricultural success in Zambia. History has shown us that future cotton production volumes will be influenced by several different factors, including; the number of cotton ginning companies in the market and their commitment to providing inputs and extension to smallholders, the effectiveness of the Cotton Board in regulating side-selling and fostering healthy competition, the outgrower scheme's reliability for both farmers and ginners, macroeconomic factors including exchange rates, and the level of government involvement in smallholder agriculture – specifically the cotton and maize sectors.

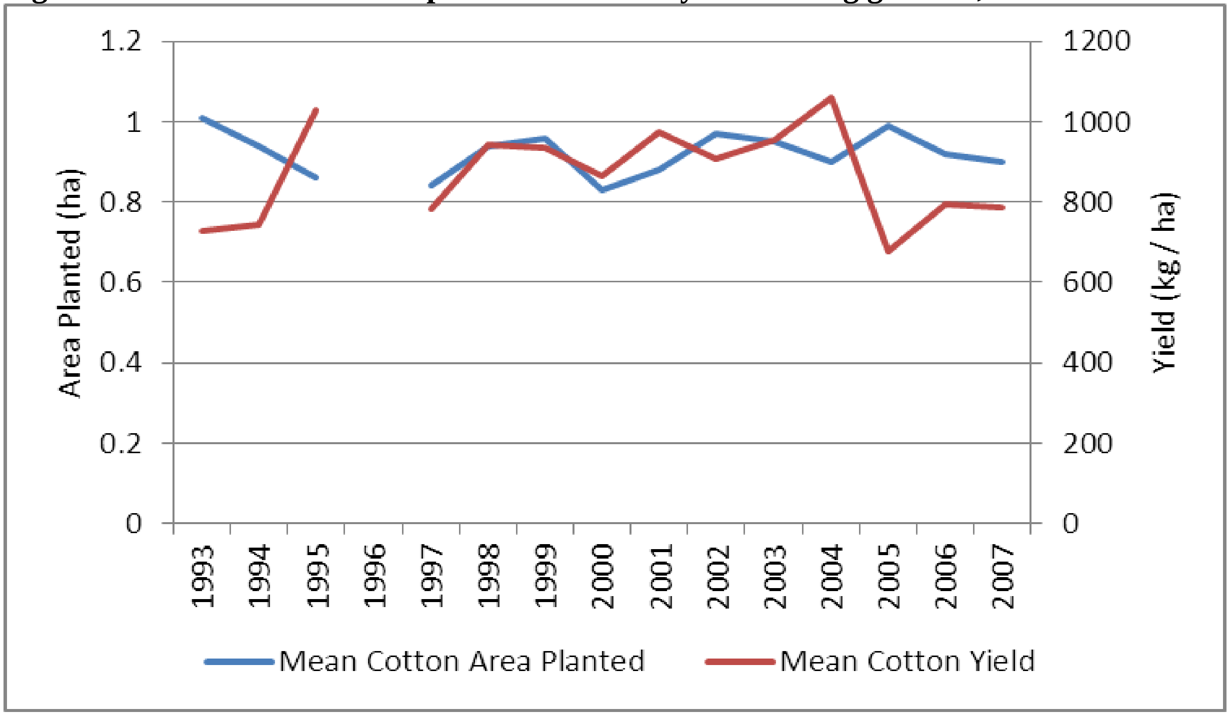
2.4 Smallholder Cotton Decisions Tracked and Analyzed Across Household Indicators

This section discusses several key findings of our Zambian cotton research and is broken into three subsections. Section 3.3.1 analyzes changes in national production volumes to help determine what farm level factors drive changes in aggregate seed cotton production. Section 3.3.2 tracks the movements of smallholder households into and out-of cotton production by examining the differences in several household characteristics among the households that chose to plant cotton and the households that did not. Section 3.3.3 presents further information on the types of farmers that entered, stayed in, exited, and stayed out of cotton production during crash years – 2000 and 2007 – and recovery years – 2001 and 2003.

2.4.1 Drivers of Aggregate Production

Overall levels of cotton production are directly affected by cotton yields, the area of cotton planted by each grower, and the number of farmers choosing to plant cotton. Figures 2.4 and 2.5 use PHS data to highlight these three determinants of production and identify which of them are most associated with aggregate production changes.

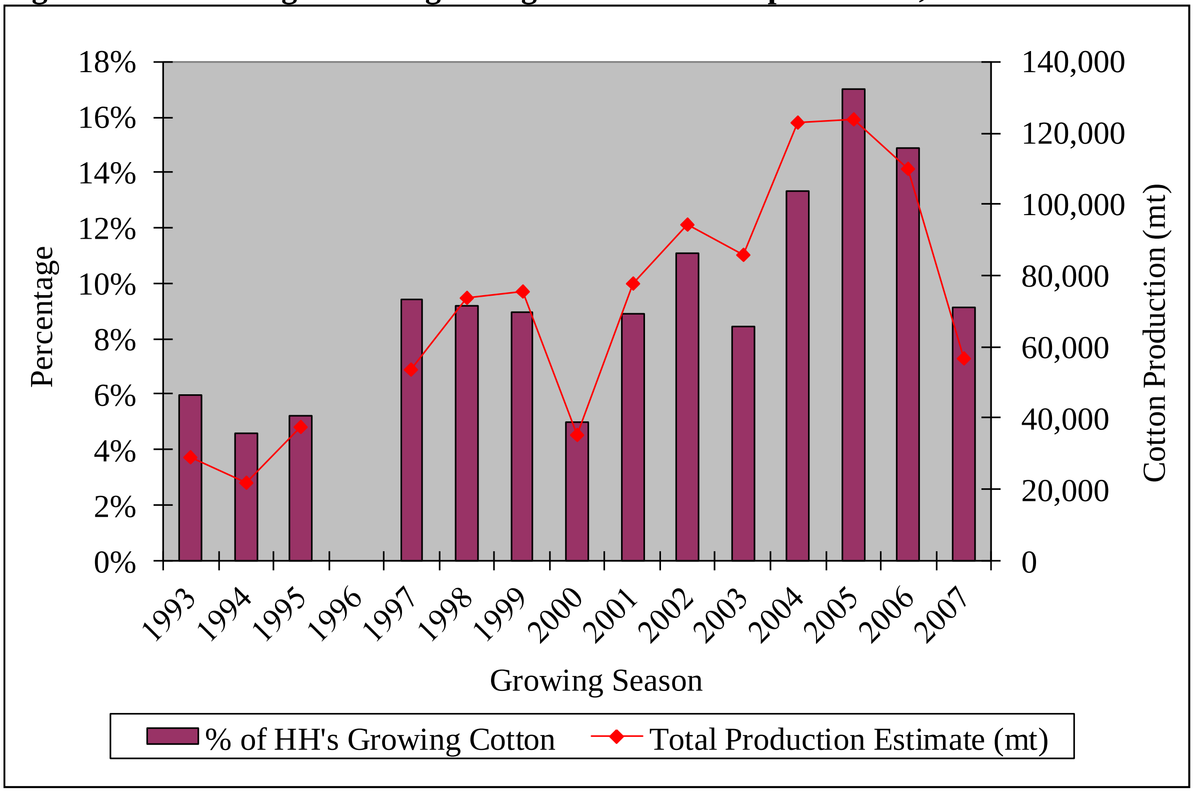
Figure 2.4: Cotton mean areas planted and mean yields among growers, 1993 - 2007



Source: Author's calculations from Post Harvest Surveys, PHS 92/93 – PHS 06/07

Figure 2.4 shows that mean household level cotton yields and areas planted have remained relatively stable over time. Figure 2.5 shows that same cannot be said for the number of farmers planting cotton, which has shown a good deal of variability. Figure 2.5 shows very similar movements in the percentage of smallholder farmers growing cotton and overall cotton production. This is confirmed by the high correlation (0.93) between the proportion of smallholders growing cotton and the national cotton production estimates and the low correlations between these estimates and both the mean area planted (0.26) and mean yield among growers (0.19). These patterns suggest that it may be important to examine the characteristics that distinguish smallholders that choose to remain in cotton even during crash years and those that choose to exit.

Figure 2.5: Percentage of HHs growing cotton and total production, 1993 – 2007



Source: Author's calculations from PHS data

2.4.2 Characteristics of Households Entering and Exiting Cotton

A descriptive analysis of the Supplemental Survey panel data provides several insights into these issues. Table 2.3 shows the percentages of cotton farmers that moved into and out of cotton production each year from 1999 to 2007, by province. A household "exits" the market if said household grew cotton the previous growing season, but did not grow cotton this growing season. Likewise, a household "enters" the market if the household did not grow cotton in the previous growing season, but did grow cotton this season. Higher enter percentages than exit percentages are an indication of growth in the number of smallholders producing cotton and, therefore, total cotton production. In all but one year – 2000, the year of the first cotton collapse – the enter percentage was higher than the exit percentage in Eastern province. The percentages for Southern and Central provinces show much more volatility from year to year. The years when total cotton production was increasing show large entry percentages and low exit percentages and the contraction years show the opposite. In 2001, Eastern province and Southern province had much higher entry rates than exit rates; and in 2003, all three provinces had entry rates that were much higher than their exit rates. These two years highlight the sector's strong recovery after the 2000 collapse. All in all, the Eastern province percentages for entry and exit are smaller than those for Central and Southern provinces, suggesting lower turnover among cotton farmers in Eastern province. This finding is consistent with PHS production data, which show less production volatility in Eastern province than in Central province and Southern province.

These entry and exit percentages are useful for looking at the cotton sector as a whole, but they do not tell anything about the actual household decisions nor do they show the differences between smallholder households that grow cotton and those households that do not, and those that enter and exit at different times.

Table 2.4: Percentage of smallholder households entering and exiting cotton by year, 1999-2007

	CENTRAL		EASTERN		SOUTHERN	
Harvest Year	% Exit	% Enter	% Exit	% Enter	% Exit	% Enter
1999	22.07%	26.70%	20.03%	37.58%	35.26%	48.46%
2000	27.28%	27.91%	31.04%	24.96%	53.62%	21.61%
2001	44.91%	32.37%	19.58%	29.50%	33.09%	60.97%
2002	No data		No data		No data	
2003	14.66%	53.65%	29.78%	44.61%	33.70%	64.60%
2004	25.67%	21.51%	22.27%	22.65%	49.71%	36.56%
2005	59.24%	44.94%	42.85%	43.88%	63.86%	61.83%
2006	33.58%	54.27%	29.85%	34.34%	35.65%	52.15%
2007	58.46%	30.11%	23.45%	24.24%	62.95%	50.93%

Note: “% Exit” is the percentage of growers from the previous year that did not grow cotton during the current year; “% Enter” is the percentage of growers during the current year that did not grow cotton during the previous year.
Source: Author’s calculations from Supplemental Survey panel data

Tables 2.4, 2.5 and 2.6 use Supplemental Survey panel data to show the total number of seasons a household planted cotton in the past ten years along with household level indicators for 2007 (the last season for which the panel collected a full set of household information). Zero years planted cotton means the household did not report planting cotton in any of the ten years; about 56% of households in Eastern, Central and Southern provinces did not plant cotton over the recorded period; about 44% did plant cotton during at least one year. The distribution of the number of years a household planted cotton is as expected – highest at zero years grown and decreasing each year (except from eight to nine years) with ten years having the lowest number of observations. Only 3% of households planted cotton in every year and less than 10% grew cotton in eight or more of the reported years. For the rest of this analysis that group of households will be referred to as “dedicated cotton growers”. These dedicated cotton growers account for only about 30% of all households that planted cotton at some point over the ten year period, which suggests that movement into and out-of cotton production over this time period was much more common than consistent cotton production every season.

Table 2.5: Household income indicators from SS08 across the number of years that a household planted cotton from 1997/98 to 2006/07

		YEARS PRODUCED COTTON										
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
# of Observations		**990**	**194**	**134**	**116**	**112**	**94**	**92**	**68**	**61**	**75**	**49**
Weighted # of Obs.		**149,302**	**29,835**	**20,864**	**19,608**	**17,654**	**13,530**	**14,882**	**9,967**	**8,724**	**9,179**	**7,329**
Per Capita HH Income	Mean	723	604	700	388	660	546	685	496	535	1,044	926
	Median	228	200	217	210	265	271	251	222	359	412	367
Cash Income From Farm Sales	Mean	1,887	1,380	1,489	1,024	1,531	1,346	856	1,068	1,070	2,127	3,709
	Median	380	513	584	416	538	654	448	615	669	906	952
	% Received	52.20%	64.33%	72.36%	75.14%	79.00%	87.64%	91.01%	95.15%	96.71%	99.54%	100%
Business Income	Mean	2,260	3,686	2,168	1,075	1,700	1,738	1,500	1,179	1,143	4,581	3,044
	Median	735	900	770	600	525	410	940	400	640	265	750
	% Received	38.15%	34.90%	45.33%	30.91%	41.09%	32.69%	47.41%	33.91%	40.25%	45.94%	44.65%
Ag-Sector Wages	Mean	856	283	225	129	407	186	190	118	43	72	203
	Median	148	40	112	70	50	170	212	120	26	75	25
	% Received	12.63%	5.74%	7.81%	22.39%	20.83%	15.28%	14.16%	11.88%	15.39%	20.71%	10.06%
Non-Ag-Sector Wages	Mean	4,014	3,703	2,441	1,582	2,457	1,858	4,638	7,756	4,180	3,737	614
	Median	980	800	600	300	500	700	2,100	7,200	2,664	1,761	860
	% Received	13.96%	8.86%	11.16%	12.80%	9.74%	13.05%	13.78%	6.07%	14.22%	8.79%	4.98%

Note: All means and medians are for the portion of the sample that received the given income type; and all incomes are in '000 ZMK.
Source: Author's calculations from supplemental survey data (SS08)

Table 2.5: Household indicators from SS08 across the number of years that a household planted cotton from 1997/98 to 2006/07

		YEARS PRODUCED COTTON										
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Household Head (HHH)	%Female	28.65%	22.14%	19.04%	15.80%	18.06%	15.94%	15.83%	15.74%	11.69%	11.71%	6.62%
	Mean Education	4.91	5.13	5.34	4.91	5.27	4.85	4.90	4.90	5.43	4.27	4.14
	Median Ed.	5	5	6	6	5	6	5	6	6	4	4
HH Size and Labor	Mean HH Size	4.65	4.88	4.63	4.57	4.81	4.91	5.23	5.14	4.96	4.90	5.07
	Mean Labor AE's	2.49	2.50	2.50	2.46	2.44	2.67	2.85	3.00	2.77	2.67	2.91
Agricultural Assets	Mean Value	5,348	5,404	4,663	3,247	3,447	6,081	3,454	3,594	3,946	8,826	7,297
	Median Value	660	895	780	685	800	870	985	1,255	1,475	2,765	1,659
	% Own Animal Traction	24.72%	30.15%	29.22%	22.35%	24.40%	31.85%	24.28%	23.24%	33.48%	39.84%	39.62%
Area Cultivated	Mean	2.94	2.94	3.03	2.62	2.98	2.76	3.30	3.07	3.15	5.66	4.75
	Median	1.56	1.82	2.06	1.91	2.19	2.03	1.94	2.84	2.63	3.21	3.18
Maize	Mean Area	1.27	1.45	1.53	1.14	1.33	1.30	1.13	1.23	1.20	1.75	1.68
	Median Area	0.81	0.81	0.91	0.81	0.81	0.81	0.81	0.81	0.81	1.22	1.22
	Mean Yield	1,498	1,612	1,504	1,252	1,366	1,528	1,366	1,402	1,434	1,800	1,661
	Median Yield	1,136	1,438	1,325	1,065	1,136	1,323	1,014	1,183	1,278	1,489	1,136
Cotton	Mean Area	0	0.91	0.71	0.68	0.84	0.81	0.68	0.93	0.94	1.24	1.66
	Median Area	0	0.75	0.6075	0.405	0.81	0.625	0.5	0.81	0.81	0.81	0.81
	Mean Yield	.	909	843	902	869	1,056	938	841	884	1,191	1,013
	Median Yield	.	700	672	731	667	938	800	668	790	956	840

Note: All calculated areas are listed in hectares (ha); all yields are calculated as kilograms produced divided by area (kg / ha).
Source: Author's calculations from supplemental survey data (SS08

Table 2.6: FRA and FISP indicators for the 2002/03 and 2006/07 harvest seasons across the number of years that a household planted cotton from 1997/98 to 2006/07

		YEARS PRODUCED COTTON										
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2003 Cotton Statistics	Share of cotton growers	0	2.40%	6.55%	8.71%	12.68%	13.25%	14.78%	10.52%	10.72%	10.95%	9.43%
	Share of cotton production	0	1.40%	4.86%	6.41%	9.39%	10.46%	12.25%	10.35%	11.33%	17.87%	15.67%
	Share of cotton area	0	1.86%	5.14%	14.10%	9.00%	12.67%	12.31%	9.28%	11.05%	13.49%	11.11%
2007 Cotton Statistics	Share of cotton growers	0	3.18%	8.21%	10.90%	11.75%	11.13%	13.73%	10.66%	9.45%	11.25%	9.73%
	Share of cotton production	0	2.28%	4.50%	6.03%	8.36%	8.96%	8.82%	8.42%	7.69%	19.24%	25.70%
	Share of cotton area	0	3.15%	5.63%	7.87%	10.75%	9.52%	10.14%	10.57%	9.64%	15.18%	17.54%
% Sold to FRA	2002/03	0.60%	0.14%	0.00%	0.86%	1.45%	3.08%	0.13%	0.00%	3.85%	5.05%	0.00%
	2006/07	10.18%	14.60%	16.65%	10.43%	9.05%	11.95%	16.50%	12.74%	11.55%	16.73%	4.50%
Mean kg Sold to FRA	2002/03	6,884	9,488	-	2,013	575	1,387	2,070	-	639	518	-
	2006/07	4,511	3,296	3,455	2,628	4,524	6,032	1,372	3,343	2,656	3,252	37,207
Median kg Sold to FRA	2002/03	6,030	14,070	-	2,013	575	1,150	2,070	-	1150	518	-
	2006/07	1,925	1,668	1,150	2,530	3,220	3,680	575	1,725	1,495	3162.5	51750
%Received FISP Fert	2002/03	10.16%	14.36%	10.28%	13.28%	7.34%	9.78%	14.07%	14.28%	12.12%	22.60%	7.17%
	2006/07	11.05%	13.87%	10.76%	10.82%	10.50%	16.20%	17.03%	14.92%	11.69%	11.88%	5.59%
Mean kg Fert Received	2002/03	426	376	440	236	243	260	224	307	319	297	157
	2006/07	368	243	443	244	331	274	216	413	366	621	312
Median kg Fert Received	2002/03	200	200	350	200	200	200	200	350	200	200	100
	2006/07	300	200	400	200	400	200	200	200	400	400	400

Source: Author's calculations from supplemental survey data (SS08 and SS04)

These tables show several expected trends among cotton producers and those that did not produce cotton. Most of the variables show a general trend across the number of years cotton was planted, though with some inconsistent up or down movements in a few of the years. The percentage of households receiving cash income from crop sales and the percentage of households that are female headed (both based on 2007 data) are the exceptions. These percentages increase and decrease, respectively, almost monotonically across the number of years cotton was planted.

Household per capita income and value of agricultural assets are particularly important statistics to this study, because they offer an idea of how well off a household is. Interestingly, mean per capita income and agricultural asset value are higher for smallholder households that never planted cotton than for all groups of households who cultivated cotton except for our dedicated growers group; these dedicated cotton growers have the highest median values of per capita income and agricultural asset holdings. Based on these two indicators, dedicated cotton growers are much better off than all other smallholder households.

Not surprisingly, the higher incomes of the dedicated cotton growers appear to be driven by cash sales: because cotton is a cash crop and the outgrower scheme provides a direct line for sales, it is logical that dedicated cotton growers have high incomes from cash sales. Another expected outcome seen in Table 2.4 is that cotton farmers as a group, and dedicated cotton farmers in particular, earned much less in agricultural sector wages than households that did not plant cotton. This is an expected result because smallholders with limited land available for cultivation and low per capita incomes tend to work on nearby fields in return for cash; but cotton farming households as a whole had higher land areas in cultivation and dedicated growers had high per capita incomes, so they did not need to work for agricultural wages as often as noncotton growing households did. Also, because cotton production requires more time and attention than many alternative crops, cotton farmers are more likely to forgo wages in other sectors in favor of spending more time working on their fields. This is made apparent by the low mean non-agricultural sector wage earnings of dedicated cotton producers and the low percentage of households receiving this income. Perhaps more surprisingly, the dedicated cotton farmers have higher mean business incomes and are more likely to receive business income than most other smallholders.

Median per capita incomes tell a different story than mean per capita incomes. Smallholders who did not grow cotton at all have a lower median per capita income than cotton growers despite having a higher mean per capita income. This discrepancy between mean and median per capita income is a result of households that did not plant cotton having the highest percentage of households in the lowest quintile of per capita income (23%), but also having several households with high incomes that pull the mean upward. In this case, the median value is more representative of the group, and we put more weight on its value for analysis purposes.

Another interesting finding is that median asset values are much higher for cotton growers than for non-growers and increase with each additional year of cotton grown, yet the percentage of households owning animal traction is not meaningfully different among most cotton growing households and non-growing households. The group of dedicated cotton farmers, however, shows a much higher percentage of animal traction ownership than other smallholders.

Median total land area cultivated is lower for non-growers than for every group of cotton growers. Mean values are higher for almost every year of cotton grown as well – only the households that grew cotton three and five years had lower means than the households that did not grow cotton. Again, the dedicated cotton farmers show the largest means and medians. These growers also had much higher areas planted in both maize and cotton than other smallholders.

Yield values show that dedicated cotton farmers also get the most out of their land. Mean and median cotton yields in 2007 were higher for dedicated cotton growers than for most other cotton growers, which suggests that experience and dedication to cotton matter in household level production. Mean and median maize yields vary greatly across groups and there is no observable pattern. However, a t-test revealed that dedicated cotton growers had a higher mean maize yield (1,701 kg/ha) than all other households (1,529 kg/ha) at the 5% significance level.

Furthermore, these dedicated cotton producing households are not appreciably more likely than other cotton producing households to have sold some of their 2007 maize harvests to the FRA or to have received FISP fertilizer (observations based on a relatively small sample). This implies that the dedicated cotton growing households are not particularly better connected to the village power structures than other smallholders; while ability to sell to FRA may not be strongly influenced by local authorities, the FISP's allocation process (as described in chapter 2) appears to be more susceptible to favored access by households connected to village powers.

An analysis of household characteristics reveals some interesting information as well. Most notably, the percentage of households that were female headed in 2007 decreases almost monotonically across the number of years cotton was grown, strongly suggesting that female headed households are less likely to plant cotton. The education level of the household head shows no strong relationship to the number of years cotton was planted, but to the extent that a trend does exist it appears that more dedicated cotton growing households have heads with lower education levels than less dedicated households. This finding is consistent with most research on formal education and involvement in agriculture in Africa, which typically finds either no relationship or a slightly negative one.

Previously in this chapter, we established that cotton production is labor intensive, so it is reasonable to expect a positive relationship between cotton cultivation and household size. The data provide some support for this expectation, with households that planted cotton in five or more seasons having more household labor, a mean of 2.98, than households that planted cotton in four or fewer seasons, a mean of 2.56 (significantly different at 1% by a t-test).

To summarize across indicators, cotton production – in particular dedicated cultivation of eight or more years over the past 10 – appears to be associated with higher household per capita incomes and agricultural asset values. This higher level of economic wellbeing is achieved despite possibly lower levels of education and no apparent greater access to government maize supports than other smallholder households. While nearly half of all smallholder households in Eastern, Southern and Central provinces planted cotton in at least one of the ten recorded growing seasons, only about 30% of these cotton cultivating households – less than 10% of all households -- chose or were able to plant cotton in eight or more of the 10 seasons. Smallholder cotton production appears to be represented better by entrance to and exit from cotton production than by consistent and dedicated cotton cultivation.

Comparison of the cotton statistics from 2003 (a recovery year) and 2007 (a crash year; see bottom portion of Table 2.5) brings to light some interesting information. In 2007, dedicated cotton growers accounted for about 53% of Zambia's cotton production and 42% of its area, while in 2003 these same farmers generated only 45% of production and 36% of area. The difference is even more pronounced when looking only at households that planted cotton in all ten of the analyzed seasons. These farmers constitute about the same share of all cotton growing farmers each year – 9.4% in 2003 and 9.7% in 2007 -- but in 2007 their shares of total cotton production and area planted increased by 64% (from 15% to 25%) and 58% (from 11% to 18%), respectively.

These increased shares for dedicated growers could come from i) an increase in their productions or areas planted from 2003 to 2007, ii) a decrease in productions and areas planted by non-dedicated growers, or iii) a combination of the two. Table 2.7 helps clarify the situation.

Table 2.7: Yields and areas planted for dedicated cotton growers and non-dedicated cotton growers, 2003 and 2007 harvest years

	Non-dedicated growers	Dedicated growers
2003 Cotton		
Mean Area Planted (ha)	0.88	1.05
Median Area Planted (ha)	0.66	0.87
Mean Yield (kg/ha)	1054.33	1246.86
Median Yield (kg/ha)	848.81	1069.96
2007 Cotton		
Mean Area Planted (ha)	0.79	1.28
Median Area Planted (ha)	0.64	0.81
Mean Yield (kg/ha)	908.06	1029.49
Median Yield (kg/ha)	739.35	861.89

Source: Author's calculations from supplemental survey data (SS08 and SS04)

Mean and median yields decreased substantially for both groups from 2003 to 2007. When considering that 2007 was the largest crash in aggregate production, the decreased yields are not surprising. The group of non-dedicated growers had a lower mean and median area planted in cotton in 2007 than they did in 2003, whereas the dedicated growers had a much higher mean area planted in 2007. We find that the increased shares of cotton production and areas planted for dedicated cotton growers resulted from a decrease in areas planted by non-dedicated growers and an increase in areas planted by some of the dedicated growers. This suggests that the 2007 crash not only saw smallholders move out of production, it saw non-dedicated households broadly decrease their areas planted to cotton while some of the dedicated growers increased their plantings.

2.4.3 Crash and Recovery Households by Indicators

We now continue our analysis of household level indicators, but we turn our attention directly to crash years and recovery years and the differences between them. We have already demonstrated the instability of cotton production (Figure 2.3), and have shown that aggregate production movements closely follow the percentage of smallholders deciding to plant cotton in a given year; so we are directly interested in the differences across indicators of households that moved into and out of cotton production during crash years and recovery years. Table 2.8 uses data from the 2001 and 2007 supplemental surveys to show household indicators for two crash years, 2000 and 2007, across four cotton planting groups: i) households that stayed out of cotton production during the crash year (i.e., did not produce during the crash year nor the previous year), ii) households that exited cotton production during the crash year, iii) households that stayed in cotton production during the crash, and iv) households that entered cotton production during the crash year. Table 2.9 uses the 2001 and 2004 supplemental survey data and the same indicators and planting groups as Table 2.8 to analyze two "recovery" years, 2001 and 2003, in which cotton production increased following the 2000 crash. All income and asset values are nominal, so absolute comparisons can only be made within each year, but relative observations across years are valid. Four important observations regarding the quality of farmers entering and exiting cotton production during crash and recovery years stand out from these tables

First, in the 2000 crash, the households that stayed in cotton had substantially higher median asset values than other groups and they also had much higher mean and median land areas, which might imply that they are the better endowed or more capable farmers. The contrast between the group of households that stayed in production and the group of households that exited production is large in terms of median asset values and land areas: households that were able to stay in cotton were clearly the best endowed in these two categories.

Second, in the 2007 crash, the differences between households that exited and those that stayed in cotton are less striking and we can no longer make the assertion that the households that stayed in production were the best endowed. The group that exited cotton had higher mean and median asset values than the group that stayed in, and they had only slightly lower land areas and median incomes. When this observation is considered along with the first observation it becomes evident that more households with better endowments left cotton production during the 2007 crash than during the 2000 crash. It can then be implied that the 2007 crash was more harmful and severe as some of the most capable cotton farmers were driven from producing the crop, an implication that is consistent with the fact that cotton production fell more precipitously in 2007 than it did in 2000 (Table 2.3).

Third, to contrast crash years with recovery years, we focus on 2000 and 2001 because of their temporal proximity and because both years of data were obtained in the same data set (SS01) and therefore the asset and income values are on the same nominal terms. In 2001 (the recovery year), households with lower land endowments and asset values relative to 2000 were able to remain in cotton production, which suggests that cotton production was seen as profitable

Table 2.7: Smallholder movements into and out of cotton for CRASH years, harvest years 2000 and 2007

		2000					2007			
		Stayed Out	Exited	Stayed In	Entered		Stayed Out	Exited	Stayed In	Entered
% of total hhs		77.14%	6.09%	12.54%	4.23%		65.35%	9.20%	18.53%	6.91%
Income Per Capita	mean	181,389	138,737	196,341	169,225		686,741	762,023	624,333	519,523
	median	50,000	53,333	128,564	83,116		211,857	240,000	297,483	262,620
Assets	mean value	677,500	944,550	1,165,320	524,785		5,145,001	5,346,134	5,169,204	3,299,071
	median value	66,000	64,667	246,333	56,667		650,000	1,390,000	1,260,000	935,000
	% owning AT	No data					24.68%	34.43%	28.91%	32.06%
	mean land area	2.43	2.56	3.63	3		2.89	3.28	3.67	2.81
	median land area	1.62	1.82	2.7	1.94		1.62	2.19	2.63	2.06
Cotton	mean # years	1.01	4.33	7.62	4.62		0.6	3.46	6.46	4.19
	median # years	0	4	8	5		0	3	6	4
Labor AEs	mean	2.89	3.03	3.17	2.8		2.49	2.42	2.79	2.59
	median	2	2	2.83	2		2	2	2	2

Note: Incomes and assets are nominal values.
Source: Author's calculations from supplemental survey data (SS04 and SS01)

Table 2.8: Smallholder movements into and out of cotton for RECOVERY years, harvest years 2001 and 2003

		2001					2003			
		Stayed Out	Exited	Stayed In	Entered		Stayed Out	Exited	Stayed In	Entered
% of hhs		77.00%	4.11%	12.71%	6.18%		69.25%	4.74%	16.96%	9.05%
Income Per Capita	mean	184,093	132,361	210,020	94,456		600,000	316,878	602,808	424,765
	median	51,333	78,000	128,564	42,057		166,800	99,553	317,533	217,667
Assets	mean value	690,115	849,208	1,029,449	733,121		3,050,334	1,959,644	2,499,901	2,516,046
	median value	66,000	120,000	205,000	60,000		415,000	462,000	640,000	580,000
	% owning AT	No data					20.22%	23.31%	26.62%	24.43%
	mean land area	2.37	3.88	3.35	3.39		2.09	2.22	2.84	2.86
	median land area	1.62	2.12	2.495	1.82		1.59	1.68	2.25	2.03
Cotton	mean # years	0.97	4.52	7.62	4.86		0.64	3.78	6.76	4.48
	median # years	0	5	8	5		0	4	7	4
Labor AEs	mean	2.91	2.93	3.12	2.88		2.28	2.23	2.45	2.3
	median	2	2	2.83	2		2	2	2	2

Note: Incomes and assets are nominal values.
Source: Author’s calculations from supplemental survey data (SS04 and SS01)

for households with smaller land areas and that cotton ginneries were willing to continue their relationships with these smaller households during the 2001 recovery.

Fourth, the group of households that exited cotton production in 2000 is similar to the group that entered cotton production in 2001. These groups have comparable median asset values and land areas as well as similar means for the number of years households planted cotton. These observations suggest that the 2000 crash did not have long-run impacts on the quality of farmers that planted cotton. We cannot explore similar relationships following the 2007 crash because we do not have data for the 2008 harvest year.

2.5 Summary of Key Findings

This chapter has discussed several important findings in Zambia's cotton sector. A few key points are highlighted and briefly summarized in this section. First, Zambia's cotton sector has been characterized by tremendous, though unstable, growth since liberalization in 1994. The concentrated sector has implemented the outgrower schemes successfully for the most part, but twice low input loan repayment rates contributed to production crashes. Low repayment rates prior to the second crash were engendered by the appreciation of the kwacha relative to the US dollar. Ginneries were forced to pay prices below their announced pre-planting prices and repayment rates fell again, followed by a production crash the following season as ginneries were more selective in their input provisions on loans.

A second important finding is that aggregate cotton production volumes move very closely with changes in the percentage of households that plant cotton in any given year, and much less with mean household yields and areas planted. This emphasizes the importance of households entering and exiting cotton production each year. Eastern province has shown relatively stable enter and exit percentages over time while Central and Southern provinces have shown more variability in these percentages. Also, households that entered cotton production for the 2001 harvest year were similar across indicators to the households that exited cotton production during the 2000 crash, implying that the sector's first crash did not have persistent effects on the quality of farmers that chose to plant cotton. The 2007 crash saw relatively higher quality farmers exit cotton production. This fact coupled with the anemic recovery in aggregate cotton production in 2008 and 2009 raises serious questions about the health of the cotton sector and its future production growth.

Third, we find that the increased shares of cotton production and areas planted for dedicated cotton growers from the 2003 harvest year to the 2007 harvest year resulted from a decrease in areas planted by non-dedicated growers and an increase in areas planted by some dedicated growers (Table 2.5). This suggests that not only did smallholders move out of cotton production in 2007, but that non-dedicated growers that still chose to plant cotton, and even some of the dedicated cotton growers reduced their field sizes.

Lastly, dedicated cotton cultivators – those households that planted cotton in eight or more of the ten seasons – had much higher per capita incomes (at least partially explained by high incomes from cash sales), asset values, and land areas under cultivation than the other household groups. These dedicated cotton growers also achieved significantly higher maize yields than non-dedicated growers but do not appear to be any more likely to have sold maize to the FRA or to have received FISP fertilizer than the other groups.

3. ZAMBIA'S MAIZE SECTOR

3.1 Introduction

This chapter begins by expanding upon maize's importance as a food crop in Zambia. It continues by discussing the Zambian government's involvement with the maize sector, as two smallholder maize cultivation support programs – the Farmer Input Support Program (FISP) and maize purchases by the Food Reserve Agency (FRA) – are explained in detail. Then it analyzes the spatial distribution of smallholder maize production, FRA maize purchases and FISP fertilizer allocation. It continues by analyzing indicators across groups of households that sold different quantities of maize to the FRA and received different volumes of FISP fertilizer. The chapter then looks at the association between trends in maize supports and smallholders' cropping decisions, and concludes with a summary of key points.

As mentioned in the introductory chapter, Zambia is accurately described as a maize-centric country. Maize meal is the food staple of choice for nearly all Zambians. Consumers consider breakfast meal to be the highest quality meal as it eliminates all the germ and pericarp, keeping only the starchy portion of maize kernels. Roller meal is considered to be of lower quality, being less refined and including some of the germ along with the starchy portion of maize kernels. Breakfast meal is preferred for its taste, and according to Agricultural Marketing Information Centre (AMIC) data from 1994 to 2009, is on average thirty percent more expensive than roller meal.

Consumers' preference for maize is echoed in production patterns, with maize being the primary crop grown among Zambian smallholder farmers. In Central, Eastern and Southern provinces, where the soil and water conditions are particularly favorable – and where 98% of all cotton is produced – 97% of smallholder farmers grew maize in the 2006/07 growing season.

The average smallholder household in this region devoted over 76% of their available farmland to maize.

Due to maize's direct influence on the livelihoods of most Zambian smallholder farmers, the national government takes an interest in the crop's production. Smallholder maize production has been supported through several different programs since Zambia achieved independence from the United Kingdom in 1964. In the 1990s, Zambia's agricultural policies became more liberalized and government financed supports to maize production were reduced but not abandoned. Since the 2005/06 growing season, the Farmer Input Support Program (FISP) and the Food Reserve Agency (FRA) have been expanded and are currently the leading agricultural supports in the country. Detailed explanations of these programs follow.

3.2 Farmer Input Support Program (FISP)

Most countries in SSA attempt to spur rural agricultural productivity and increase food security through programs that promote fertilizer use among smallholder farmers. While there has been considerable variation in the implementation details across time and countries, the general framework for these programs includes subsidized fertilizer prices and some level of government involvement in distribution, ranging from full distribution authority to distribution supports to private retailers through rural credit supports. The economic benefits of these programs, especially when other possible agricultural supports are considered, vary greatly across program designs (Crawford et al 2006). Zambia has employed several different fertilizer promotion programs since independence in 1964.

The post-colonial Government of Zambia managed the import, distribution, and pricing of fertilizer through NAMBOARD, the state marketing board, until the early 1990s, at which time the government relinquished its managerial position in the industry and allowed private sector participation (Jayne et al 2002). The government's reduced involvement in the fertilizer industry was one of many policy changes made to liberalize Zambia's agricultural sector. This liberalization emerged in response to a number of factors: an upsurge in ideological commitment in western (donor) countries and multi-lateral aid organizations to "free market" solutions, political pressures brought on by the government's broken promises of low maize meal prices to consumers, and macroeconomic mismanagement in the 1980s including large external debts and currency overvaluations (Pletcher, 2000).

Since this period of liberalization, however, the Zambian government has continued to play a significant role in the fertilizer industry with fertilizer subsidies and supports to smallholder farmers. The government's continued efforts to support fertilizer usage are not necessarily misguided, as research by Deininger and Olinto (2000) found strong evidence that increasing the number Zambian smallholders applying fertilizer to their maize fields would significantly increase maize production and that fertilizer application in small doses would be profitable for many farmers. Donovan et al (2002) found fertilizer application to maize fields could be quite profitable for some smallholders, but they also found that maize fertilizer response rates were highly variable in Zambia.

Throughout the 1990s the government's involvement in fertilizer distribution varied as several different distribution methods were employed. One program of meaningful size was FRA loans used to make fertilizer obtainable for smallholder farmers. The FRA fertilizer loan program distributed fertilizer to smallholders for the 1996/97 and 1997/98 growing seasons. Although the program distributed more fertilizer than the private sector for both of these seasons (Jayne et al, 2002), the program faced several challenges including high costs of distribution and very low loan recovery rates. These problems made the program expensive and unsustainable, and the fertilizer distribution function of the FRA was eliminated for the 1998/99 season. The problem of low loan recovery rates was not unique to the FRA program: even private agents contracted by the government to distribute fertilizer never achieved a loan recovery rate greater than 43% prior to 2002 (Govereh et al, 2002).

In the 2002/03 growing season, the government heavily involved itself in fertilizer distribution once again with the implementation of the Fertilizer Support Program (FSP). The program's name was changed prior to the 2009/10 growing season to the Farmer Input Support Program (FISP). For consistency purposes, this paper retroactively applies the program name FISP to all FSP activities. The FISP is designed to allow smallholder farmers to purchase packets containing maize seed and fertilizer at a price equal to or less than 50% of the market price. FISP packets sold to smallholders contain inputs calculated for farming one hectare of maize. A few of the explicit FISP purposes as listed in their annual reports are to increase private sector participation in input provision, ensure timely input delivery, improve farmer access to inputs, and break the monopolies of input provision. The program has been expensive, consistently accounting for 35-40% of the public budget to agriculture (Xu et al, 2009).

Table 3.1 shows the changes in FISP fertilizer quantities distributed and the number of intended recipients of FISP fertilizer for every growing season since the program was initiated. Only the 2004/05 and 2007/08 growing seasons had lower fertilizer quantities and fewer intended recipients than the previous year. That is to say the FISP has typically been increasing its distribution since inception. Since 2007/08, the distribution increases have been particularly striking. From 2007/08 to 2009/10 the number of intended beneficiaries increased by over 340% and the tonnage of subsidized fertilizer distributed increased by 120%.

Table 9: FISP distribution, growing seasons 2002/03 through 2009/10

Growing Season	Number of Intended Recipients	Total Fertilizer Distributed (mt)	Subsidy (%)
2002/03	120,000	48,000	50%
2003/04	150,002	60,000	50%
2004/05	75,000	30,000	50%
2005/06	125,000	50,000	50%
2006/07	145,375	58,000	60%
2007/08	120,250	48,500	60%
2008/09	200,000	80,000	75%
2009/10	534,190	106,838	NA

Source: MACO FISP manuals

The FISP's structure for distributing subsidized fertilizer and maize seed was changed following the 2008/09 growing season. We do not wish to ignore the current FISP fertilizer distribution techniques, but because this study is conducted using data collected prior to the 2009/10 growing season we directly focus on the FISP framework used prior to that season.

In principle, farmers wanting FISP fertilizer must complete an extensive application process. The farmer must be a member of a cooperative or a farmer organization and they must apply to receive FISP fertilizer through their respective organization – individuals cannot apply by themselves and farmers must have the ability to farm between one and five hectares for their application to be accepted. The regional cooperatives and farmer organizations must then submit an application to the District Agricultural Committee[3] (DAC) on behalf of their members. The DAC reviews the applications and reports their desired fertilizer distributions to the Program Coordination Office (PCO). With all the application information from the DACs, the PCO

[3] The DAC was changed to the more localized Camp Agricultural Committee (CAC) in 2009 with the intent of ensuring more accurate distribution of fertilizer. Each CAC consists of seven community members, one from each of the following sectors or groups; church, NGO, civil servant, chief representative, youth, agricultural cooperative, and MACO. The CAC verifies the names on the cooperative applications and must be present when fertilizer is handed out.

determines who should receive subsidized fertilizer. When a cooperative learns that some of its members will be receiving FISP fertilizer, they are responsible for depositing these members' portion of the fertilizer costs (usually 50%, but it varies year to year) into a bank account set up to make payments to the private fertilizer distributors. The government will then match their portion of the payment in the same account. When the full payment from both the farmer coops and the government is received, the bank transfers the funds to accounts held by the private traders who then begin distributing the fertilizer as it becomes available. As one of the explicit goals of FISP is to increase private sector input provision, the government does not actively involve itself in fertilizer distribution; private fertilizer companies are selected for distribution to the districts. In order for farmers to receive fertilizer from the traders, they must first pick up their Authority to Collect (ATC) slips from the DAC. Then, when the fertilizer is distributed by the private retailers, the famers must take their ATCs and a form of identification to their district depots to receive their fertilizer in person. Each person is supposed to receive only one packet from FISP which contains enough maize seed and fertilizer for one hectare of maize.

In principle, this design is meant to allow Zambian smallholder farmers who otherwise might not apply fertilizer to their fields to fertilize one hectare of maize and increase their yields; smallholders who already buy fertilizer to receive more fertilizer or decrease their input costs and increase their profits from maize sales; and private fertilizer distributors to benefit from the increased volume of fertilizer sales, lower their average fixed costs, and increase profits. But in the real life execution of FISP, there is evidence that these benefits are much smaller and in some cases nonexistent. Research by Xu et al (2009) found that in some cases FISP fertilizer can "crowd out" private fertilizer purchases. A World Bank (2009) study estimated that in the 2007/08 growing season FISP fertilizer displaced about 10% of private fertilizer sales.

Furthermore, Xu et al (2009) concluded that in places with an already strong fertilizer market an increase in FISP fertilizer received did more than displace private retailers, it resulted in a net decrease in total fertilizer used. The authors explain this result by suggesting that government announcements of planned FISP fertilizer distributions in an area might cause private fertilizer sellers to consider distributions to said area to be unprofitable and to discontinue their business activities there, which could decrease total fertilizer volumes sold and used in the area. Table 3.2 shows that the districts with the highest percentages of smallholders already purchasing fertilizer through private retailers have higher average FISP fertilizer receipts per household.

The FISP's success in increasing rural productivity and alleviating poverty is sensitive to properly targeting "small farmers lacking effective demand" (Crawford et al, 2006). Unfortunately, another problem with FISP's implementation is that the intended recipients are not the actual recipients in many cases. In the 2005/06 growing season, FISP distributed packets intended for farming one hectare of land, which included 400 kg of fertilizer – 200 kg of basal fertilizer and 200 kg of top dressing[4]. Following FISP's implementation design, a farmer could not receive more than one packet and, therefore, no more than 400 kg of fertilizer. However, the PHS data for the same season suggest that 15% of households that obtained FISP fertilizer received more than 400 kg, and the mean and median kg received among them were 998 kg and 800 kg, respectively. This observation coupled with the information presented later in Table 3.5, which shows that wealthy farmers appear much more likely to receive FISP fertilizer than poorer farmers, suggest that actual distribution of FISP fertilizer differed from mandated distribution in ways that favored better-off farmers.

[4] For the 2009/10 growing season, FISP reduced the intended packet size to 200 kg of total fertilizer per farmer – 100 kg of basal fertilizer and 100 kg of top dressing – with the direct intentions of reaching more famers and improving the distribution.

Table 3.2: FISP fertilizer receipts in 2006/07, % of households purchasing fertilizer from private dealers, and % producing cotton, by district in cotton producing provinces

District	Mean FISP fertilizer receipts across all household (kg)	% of HHs purchasing fertilizer from private input dealer in 2003/04	% of HHs producing cotton
Kabwe	112.2	57%	0%
Kalomo	80.7	22%	4%
Mazabuka	67.9	32%	20%
Choma	66.2	27%	5%
Mkushi	62.6	56%	0%
Chibombo	53.5	56%	8%
Mumbwa	52.5	25%	29%
Kapiri mposhi	47.6	33%	8%
Chadiza	42.5	30%	37%
Monze	41.6	16%	14%
Saivonga	40.0	7%	9%
Chipata	39.5	35%	30%
Petauke	38.7	5%	29%
Lundazi	35.7	24%	38%
Katete	35.4	5%	69%
Serenje	26.1	13%	0%
Gwembe	24.0	24%	16%
Livingstone	13.3	16%	0%
Itezhi tezhi	10.7	14%	3%
Namwala	8.7	9%	13%
Kazungula	7.7	0%	2%
Nyimba	6.4	3%	30%
Chama	5.8	2%	58%
Mambwe	1.2	4%	46%
Sinazongwe	0.0	3%	24%

Source: Author's calculations from supplemental survey data (SS08)

Yet another issue with the FISP's fertilizer distribution methods is late delivery. Several researchers, including Xu et al (2009) and Minde et al (2008), have emphasized that the timing of fertilizer application is very important, and that yields are maximized when fertilizer is applied "on time". Estimates of the frequency of late delivery vary, but all are high: World Bank (2009) estimates that 70% of FISP fertilizer was delivered late during the 2007/08 growing season, while CSO/MSU Supplemental Survey data for the same season indicate that 30% of FISP recipients reported that FISP fertilizer was not available when they needed it.

To summarize, Zambia's government has tried to increase fertilizer use by smallholder farmers for several decades with different support programs. Most recently, the FISP has tried to increase smallholder access to cheap fertilizer nationwide. FISP volumes have grown considerably since the program's inception in the 2002/03 growing season and its plans for the 2009/10 season include more targeted smallholders and more fertilizer than ever before, with 534,190 intended recipients and about 107,000 metric tons of fertilizer to be distributed. Unfortunately, the program has shown evidence of some harmful unintended effects including side-selling of fertilizer, late fertilizer delivery, displacement of private fertilizer purchases and even less total fertilizer use in some areas with already strong fertilizer access.

3.3 Food Reserve Agency (FRA)

The other main agricultural support program in Zambia is the Food Reserve Agency (FRA). FRA's explicit goal according to the agency's website is "to stabilize National Food Security and market prices [through] a sizeable and diverse National Strategic Food Reserve in Zambia by 2010." FRA buys several agricultural commodities directly from rural farmers and stores them in the storage facilities that the agency manages. The primary commodity purchased by FRA is maize. For the 2007/08 growing season, maize accounted for over 98% of FRA's planned tonnage of agricultural purchases.

FRA was founded in 1996 under the Food Reserve Act. The agency is operated by Zambia's Ministry of Agriculture and Cooperatives (MACO) and is funded through MACO's share of government funds. The Minister of MACO appoints an advisory board that oversees the management of the program. The managers work with district agricultural cooperatives who communicate with the smaller, primary cooperatives of which smallholder farmers are members. Information is passed up through the chain of command, but the pertinent decisions (i.e., targets for commodity prices and quantities) are made by the advisory board.

For the 2009/10 growing season, FRA planned about seven purchasing depots in each district for a total of 469 nationwide. Smallholder farmers can sell their maize to FRA agents at these depots at a fixed, previously announced FRA price, which in most years has been well above the open market price (Table 3.3). The maize can be delivered by any individual smallholder or by a member of any cooperative or a farmer's association. FRA buys maize from June through September each year or until funds for purchases run out. In four of the past five growing seasons the maize purchase period was extended through December as additional funds became available. This timing is not an issue for most farmers because 76% of all maize sales by Zambian smallholders in the 2006/07 harvest season were made in July, August and September. Each maize transaction must be a minimum of 10 bags of 50 kg and a maximum of 153 bags of 50 kg, and all bags must be free of "foreign matter". Payment for maize is not immediate: farmers are expected to leave their maize at the depot and trust that their payment will come later.

The Food Reserve Act was amended in 2005 to include the functions of distributing wealth to rural farmers and providing market access to farmers in remote areas. In the years following these amendments, FRA has dramatically increased the tonnage of maize it purchases from smallholder farmers (Table 3.3).

Table 3.3 shows that the FRA began by purchasing moderate quantities of maize at modest prices during the 1996 and 1997 harvest years. The following four years saw no FRA maize purchases due to a lack of funding for the program. Over this period of inactivity, Zambia experienced annual inflation rates of more than 25% in 2001 and 2002, which contributed to the median price received by smallholder farmers doubling from under 13,000 kwacha per bag of 50 kg in 1999/00 to over 29,000 kwacha in 2001/02. When the FRA resumed maize purchases in 2001/02, it offered farmers 44,400 kwacha for their 50 kg bags of maize, which is the highest price offered through at least 2007 and about 15,000 kwacha more per bag than smallholders were receiving in sales to private traders. The FRA increased its purchase volumes by about 100% in each of the next two years and decreased their purchase price to within 5,000 kwacha of the market price. After a minor decrease following the Food Reserve Act amendment in the 2005 season, the FRA drastically increased their maize purchases to around 390,000 metric tons in each of the next two seasons. This increase is made even more significant by the fact that FRA maize purchases had exceeded 100,000 tons in a season only once before. The FRA allowed their maize price to grow slowly over this time from 36,000 kwacha in 2003/04 to 38,000 in 2006/07. In every year that the FRA has made maize purchases, the FRA purchase price for maize has been above the market price received by farmers.

Table 3.3: FRA maize purchase quantities, mean FRA prices, and median maize prices received by farmers

Harvest Year	FRA Maize Purchases (mt)	FRA Price per 50 kg Bag	Market Price Received by Farmers per 50 kg Bag
1996	10,500	11,800	No data
1997	4,989	7,880	7,700
1998	0	No purchases	13,250
1999	0	No purchases	13,800
2000	0	No purchases	12,550
2001	0	No purchases	20,400
2002	23,535	44,400	29,100
2003	54,847	30,000	25,150
2004	105,279	36,000	No data
2005	78,566	36,000	32,200
2006	389,510	37,000	29,450
2007	396,450	38,000	33,550

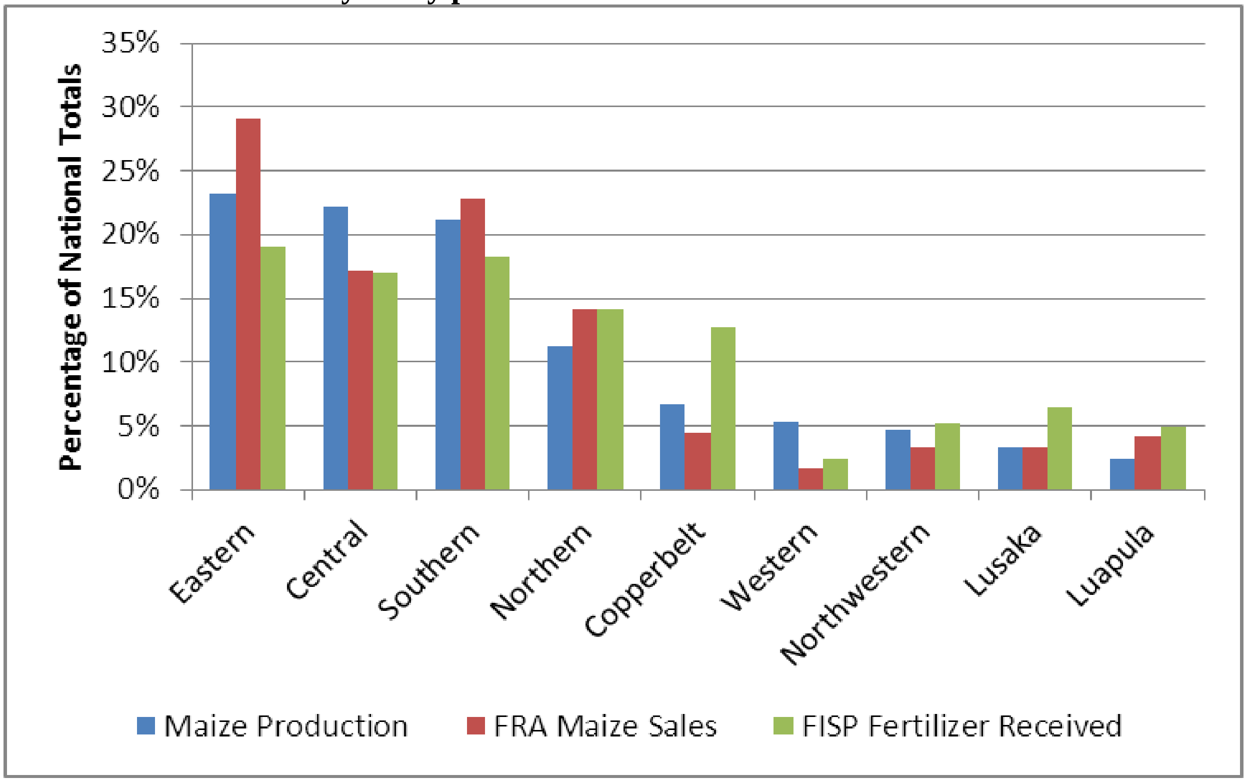
Note: FRA prices are national means. Market prices received by farmers are national medians reported in PHS.
Source: FRA and author's calculations from PHS data

3.4 Spatial Distribution of Maize Production and Maize Support Volumes

In this section, we look at the spatial distribution of smallholder maize production, FRA maize purchase quantities and FISP fertilizer allocation. Our analysis begins at the province level, but concludes at the district level. We use PHS data along with annual FISP implementation manuals produced by MACO as our data sources for this chapter.

Maize is cultivated by smallholders throughout Zambia primarily for household consumption, although about 30% of households sold some of their maize production in 2007 (SS08). The southern and eastern areas of Zambia are best suited for maize production, while the northern and western regions of the country have higher annual rainfalls, less fertile soils, and less maize production. Referring back to Figure 2.1, AEZ 1 and AEZ 2a are relatively better suited for maize production – as they are for cotton production -- compared with AEZ 3a and AEZ 3b.

Figure 3.1: National shares of maize production, FRA maize sales, and FISP fertilizer received in 2007 harvest year by province



Source: Author's calculations from PHS data (PHS 2007)

Figure 3.1 shows that Central, Eastern and Southern provinces led the country in maize production in 2007; these provinces' smallholders harvested two thirds of Zambia's maize. Luapula, Lusaka, Northwestern, Western and Copperbelt provinces produced disproportionately small shares of the country's maize: these provinces combined for about one fifth of the national smallholder output. Northern province produced less than 10% of the country's smallholder maize in 2007, which places it in between the high and low share groups.

Also shown in Figure 3.1 are the province shares of FRA maize purchases and FISP fertilizer received. The FRA purchase shares are close to the maize production shares for each province. However, Central and Western provinces accounted for much smaller percentages of FRA sales than their production percentages, while Eastern province accounted for a disproportionately high percentage of FRA sales despite leading the country in maize production.

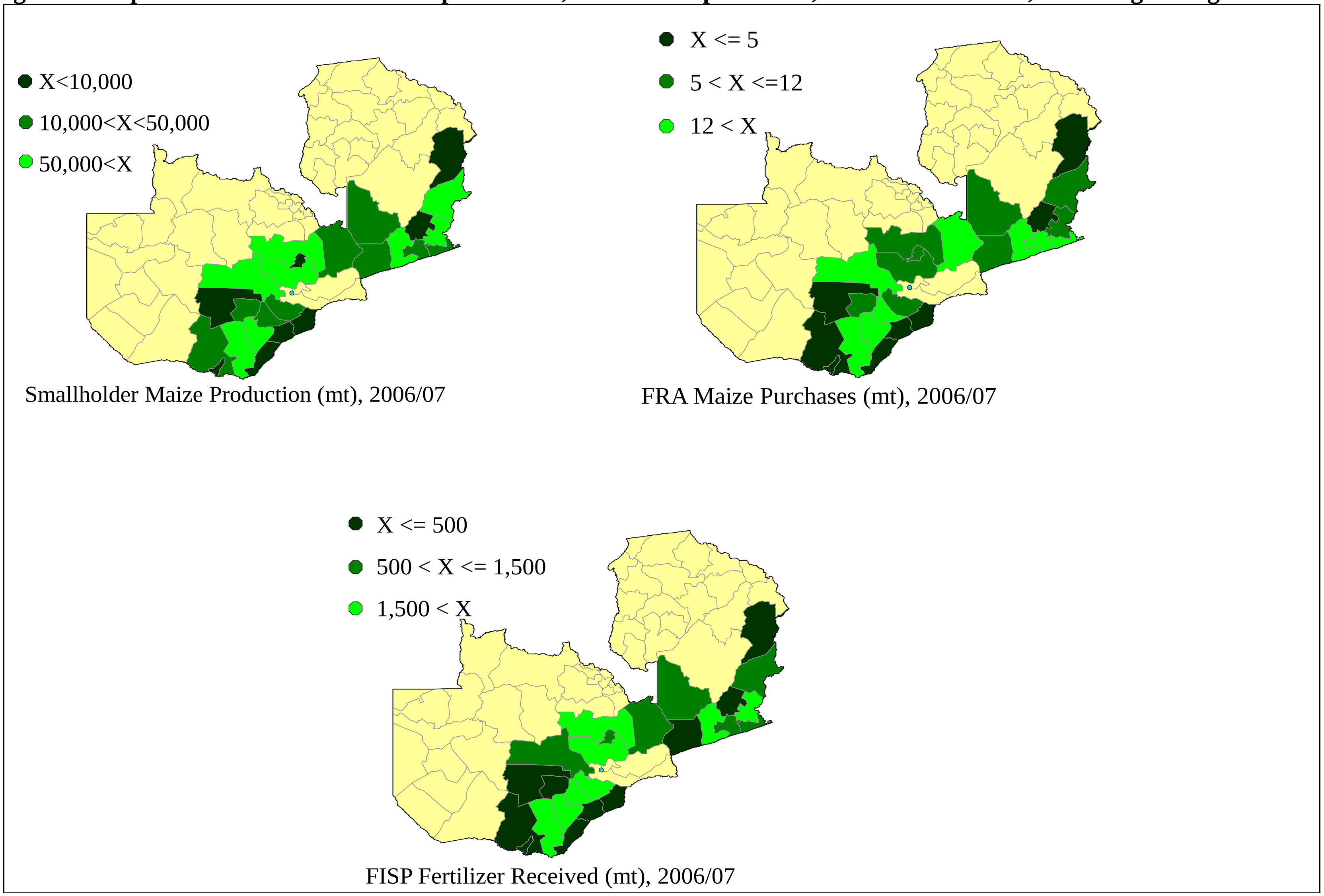
FISP fertilizer distribution shares show more consistency with maize production shares than the FRA purchase shares do. For the largest three maize producing provinces, FISP fertilizer shares were lower than maize production shares. Conversely, all but one of the other six provinces had FISP fertilizer shares that were higher than their maize production shares. Although the largest maize producing provinces received the highest portions of FISP fertilizer, the relative ratios of production shares to FISP fertilizer shares seem to suggest that FISP fertilizer distribution is more deliberately designed to increase smallholder maize production in the provinces where production is lowest.

This point is corroborated by district level data. In the 2006/07 growing season, all of the country's 72 districts received subsidized fertilizer through FISP. FRA made maize purchases in 64 districts, but was absent from 8 districts. The widespread reach of these two programs reflects the government's clear efforts to extend supports for maize production to most smallholders countrywide. However, as Figure 3.1 shows, the FRA and FISP supports remain heavily concentrated in Southern, Eastern and Central provinces. For this reason, and because these provinces are the dominant cotton producers, we focus on these three provinces.

Figure 3.2 highlights the district level distribution of smallholder maize production in Central, Eastern and Southern provinces, and displays FRA maize purchases and FISP fertilizer distribution respectively in the same area. These maps show a great deal of overlap and consistency in the spatial distributions of maize production and maize supports. Maize production appears to more closely related to FISP fertilizer distributions than to FRA maize purchases, and this is, in fact, the case in the cotton growing provinces and the country as a whole. In the cotton growing provinces, an analysis of district level maize production from SS08 data along with FISP fertilizer distribution quantities and FRA maize purchase quantities for the 2006/07 growing seasons revealed a stronger correlation between maize production and FISP fertilizer quantities (0.82) than between maize production and FRA purchase quantities (0.50). The correlation between FRA and FISP (0.59) is strong as well.

The biggest inconsistency between the FRA maize purchases and maize production maps is in Central province where it seems that the western districts produced a lot of maize but evidently did not have a proportionate opportunity to sell their harvests to the FRA. The biggest difference between the FISP and maize production maps lies in Southern province. The FISP fertilizer map shows that districts either received large amounts or small amounts of fertilizer with no districts in between. The smallholder maize production map shows a more even distribution across districts with several districts in each of the three harvest quantity range.

Figure 3.2: Spatial distributions of maize production, FRA maize purchases, and FISP fertilizer, 2006/07 growing season



Source: Author’s calculations from PHS data

3.5 Household FRA Sales and FISP Receipts by Indicators

Although the FRA increased their maize purchase volumes dramatically for the 2005/06 and the 2006/07 growing seasons, not every smallholder farmer has the opportunity to sell their maize to the FRA. Moreover, smallholder farmers are not a homogenous group: there is a great deal of variation across households in their land holdings, incomes, and productive asset values among other things. Table 3.4 shows that a household's ability to sell maize to the FRA appears to vary greatly across these characteristics and it corroborates our assertion that the FRA has not purchased maize from all smallholder groups equally.

The households that sold maize to the FRA made up just 11.6% of Zambian smallholders in our area of interest in 2006/07, but these households had much higher per capita incomes, productive asset values, and land holdings than households that were not able to sell to the FRA. When the group of smallholders that sold to the FRA is split into quartiles based on the quantity of maize they sold, the household indicators show that the farmer group that sold the most maize to the FRA is much better off than all other smallholder households. This group had substantially higher land holdings, asset values, and per capita income. The lowest quartile has numbers that are comparable to the group of farmers that did not sell to the FRA. In fact, the group with the smallest sales volume to the FRA had a lower mean per capita income than the group with no FRA sales. The differences between these two groups are in asset values and land holdings, which the lowest quartile of households show significantly larger mean values for than the no sales group.

The data also indicate that households that sold to the FRA are much more likely to receive FISP fertilizer than households that did not. About 8% of households that did not sell to the FRA received FISP fertilizer in the same year, while over 42% of households that did sell to

Table 10: Household indicators by sale of maize to FRA during 2006/07 cropping season

Group	% of HHs	Quantity of FISP fertilizer received		% purchasing fertilizer from private input dealers in 2003/04	% receiving FISP fertilizer in 2003/04	Mean per capita income ('000 ZK)	Mean value of productive assets ('000 ZK)	Mean land holdings (ha)	Cotton	
		Mean (kg)	Median (kg)						% producing in 2006/07	Mean production among those producing (kg)
Did not receive FISP fertilizer	88.2%	-	-	20.1%	8.5%	609	4,144	2.86	25.5%	831
Quartiles of those receiving FISP fertilizer										
1 (25% receiving the least)	2.5%	98	100	19.7%	33.7%	638	4,193	2.85	24.2%	713
2	4.4%	221	200	40.6%	16.7%	995	9,168	4.24	24.3%	1,145
3	3.5%	400	400	34.8%	46.8%	1,499	16,477	5.34	23.7%	1,109
4 (25% receiving the most)	1.4%	1,028	800	50.0%	34.0%	1,936	22,509	7.60	13.1%	2,742
All HHs receiving FISP fertilizer	11.8%	341	200	35.5%	31.3%	1,177	11,819	4.66	22.8%	1,141

Note: Data are for cotton producing provinces considered in this report: (Eastern, Central, and Southern).
Source: Author's calculations from supplemental survey data (SS08

Table 3.5: Household indicators by receipt of FISP fertilizer in 2006/07 cropping season

Group	% of HHs	Quantity of FISP fertilizer received		% purchasing fertilizer from private input dealers in 2003/04	% receiving FISP fertilizer in 2003/04	Mean per capita income ('000 ZK)	Mean value of productive assets ('000 ZK)	Mean land holdings (ha)	Cotton	
		Mean (kg)	Median (kg)						% producing in 2006/07	Mean production among those producing (kg)
Did not receive FISP fertilizer	88.2%	-	-	20.1%	8.5%	609	4,144	2.86	25.5%	831
Quartiles of those receiving FISP fertilizer										
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2	4.4%	221	200	40.6%	16.7%	995	9,168	4.24	24.3%	1,145
3	3.5%	400	400	34.8%	46.8%	1,499	16,477	5.34	23.7%	1,109
4 (25% receiving the most)	1.4%	1,028	800	50.0%	34.0%	1,936	22,509	7.60	13.1%	2,742
All HHs receiving FISP fertilizer	11.8%	341	200	35.5%	31.3%	1,177	11,819	4.66	22.8%	1,141

Note: data are for cotton producing provinces considered in this report: (Eastern, Central, and Southern)
Source: Author's calculations from supplemental survey data (SS08)

the FRA were able to obtain FISP fertilizer. This point is strengthened by the shares of households receiving FISP across quartiles: the top two quartiles had a higher percentage of households receiving FISP fertilizer than the bottom two, but the difference is less than 10%, which seems to show that households that sold any maize at all to the FRA were more likely to receive at least some fertilizer from the FISP. However, households that sold more maize to the FRA received more FISP fertilizer on average, as more the mean kg of FISP fertilizer received among those receiving it increases across quartiles.

Table 3.4 shows comparable indicators to those shown in Table 3.4 by groups of households that received different quantities of FISP fertilizer. As with FRA sales, households that received FISP fertilizer for the 2006/07 cropping season have higher land holdings, productive asset values, and per capita incomes than the group of households that did not obtain FISP fertilizer. Unlike FRA sales groupings, there appears to be a much more even distribution of these values across quartiles of FISP fertilizer received. The income, asset value and land holding indicators increase monotonically across the groups and the group receiving the most fertilizer has the highest values of each indicator, but they are not as dramatically better off as the group with the highest quartile of FRA sales. Quartile 1 of those receiving FISP fertilizer in Table 3.5 shows indicator values almost identical to the group that received no FISP fertilizer, whereas quartiles 2, 3 and 4 appear to be much better off than the group that received no fertilizer.

About 31% of households that received FISP fertilizer in 2006/07 also received it in 2003/04, and only 8% of the households that did not obtain FISP fertilizer in 2006/07 were able to obtain it in 2003/04. Considering that FISP targeted about twice as many households in 2006/07 as in 2003/04 (Table 3.1) it appears that many of the same households receive FISP fertilizer from year to year. Households that received FISP fertilizer in 2006/07 were more likely to have purchased fertilizer from a private dealer in 2003/04. 50% of the households with the largest FISP receipts in 2006/07 were able to purchase fertilizer from a private dealer in 2003/04, which supports the possibility that FISP fertilizer can displace private fertilizer sales.

Table 3.5 provides additional evidence regarding the bias of FISP fertilizer distribution towards better-off farmers, as discussed in the FISP section. The mean and median kg of FISP fertilizer received among all households that received it are less than the 400 kg of fertilizer in a standard packet distributed by the FISP. Only 30% of these households received the expected 400 kg of fertilizer: 60% received less than 400 kg: and about 10% received more than 400 kg. These portions of households that obtained quantities of fertilizer that did not equal the quantity distributed in the standardized packets suggest that the many of the packets were split, with most farmers obtaining less than 400 kg while the group of wealthiest farmers obtained much larger quantities.

Households that sold maize to the FRA in the 2006/07 growing season were slightly less likely to have planted cotton than those households that were not able to sell to the FRA. There is no discernable trend across quartiles, but quartile 4 had the lowest percentage of households that produced cotton with 16%. The mean cotton production among growers shows a clear increasing trend across quartiles. At over 8,000 kg of seed cotton, quartile 4 had the highest mean cotton production among growers. Quartile 3 had a significantly lower production mean of about 2,700 kg, but the divide is most pronounced between quartiles 2 and 3. Quartiles 1 and 2 had low mean cotton production values of 640 and 784 kg respectively that were not much different from the group of households that did not sell maize to the FRA whose mean cotton production among growers was 665 kg. The two quartiles that sold the most maize to the FRA had significantly larger cotton production means than the other groups.

To summarize, quartiles 3 and 4, who sold the highest maize volumes to the FRA, were not more likely to produce cotton than the other groups, but the households within those quartiles that did produce cotton were much more productive in terms of seed cotton output volumes. It appears that the "best" or most productive cotton producers in the 2006/07 growing season were also able to sell the highest volumes of maize to the FRA.

These apparent relationships between FRA sales and cotton production are mirrored in Table 3.5 which shows FISP fertilizer receipts and cotton production. As with FRA sales, households that received FISP fertilizer were not more likely to produce cotton in 2006/07 than households that did not receive fertilizer through the FISP. Again, the highest quartile of FISP fertilizer received had the lowest percentage of households planting cotton with 13% and the highest mean cotton production among cotton growers with about 2,740 kg. However, the differences across the bottom three quartiles and the group that did not receive FISP fertilizer are quite small. With values of about 1,100 kg each, quartiles 2 and 3 had higher mean cotton productions than the group that did not receive FISP fertilizer, which had a mean of 830 kg. The spread of mean cotton production values across quartiles 1, 2, and 3 and the group that did not receive FISP fertilizer is only about 390 kg; or only about 55% of the smallest mean production value, 710 kg, which was the mean cotton production for quartile 1.

These data suggest that the quartile of households that received the highest volumes of FISP fertilizer were the most productive cotton farmers in the 2006/07 growing season, although they were less likely to have planted cotton. Below the top quartile of FISP fertilizer received, the relationship between cotton production and FISP fertilizer is much less obvious as the three lowest quartiles and the group that did not receive FISP fertilizer had comparable mean cotton production values.

3.6 Effects of Maize Supports

FRA and FISP supports to smallholder farmers combine to make maize a more attractive crop to grow relative to unsupported crop options. FRA makes maize easier to sell in rural areas and consistently pays farmers a higher price for their output (Table 3.3), while FISP reduces farmer input costs and can increase yields. These supports are aimed to increase national food security through increased aggregate maize production, and to increase household food security through increased food production and incomes for smallholder households. However, looking at aggregate national data can hide a great deal of variability at the household level. So, we choose to look at the effects of the supports on individual household level decisions. There are two main ways that maize supports can affect smallholder behavior and planting decisions. The first is by encouraging farmers that would otherwise not plant maize to plant it. The second is by encouraging farmers that already plant maize to devote a greater land area to the crop, possibly at the expense of other crops such as cotton.

Table 3.6 displays the percentage of smallholder households planting maize and the mean area of land devoted to maize production among those growing it for all nine Zambian provinces for the harvest years 2000 through 2007. Some provinces saw increased participation in maize production among smallholders, while others, namely Western and Central provinces, saw more dramatic increases in areas planted. Luapula, Northern and Northwestern provinces – not traditionally large maize producers – had relatively low participation rates at the beginning of the period, but much higher participation rates at the end of the period after FRA and FISP had been active together for several years. The largest increases in maize participation took place from the 2004 to the 2005 harvest season, with participation rates remaining at these higher levels through 2007.

Despite large maize participation rate changes for several provinces, our three provinces of interest – Central, Eastern and Southern – saw small changes in maize participation rates. However, as these provinces are the center of the traditional maize belt in Zambia, the share of households producing maize in these three provinces was well over 90% at the start of this timeframe, so there was very little room for growth. These farmers did devote more land to maize production after the 2004 harvest year as the mean area planted in maize increased over this period, yet a more detailed analysis is needed to separate the partial effects of FRA and FISP maize supports on household level decisions of what area to plant in maize. All three provinces saw a decrease in mean area planted in maize from the 2003 harvest year (the first year that FISP began to operate) to the 2004 harvest year, but increasing maize areas for each year after that. For the 2003 to 2007 period when both programs were operating, the highest mean maize area planted for all three provinces was in 2007.

3.7 Summary of Maize Sector and Government Supports

It is hard to overstate maize's importance to Zambian smallholder households. It is the food of choice and about 90% of all smallholder farmers harvested maize in 2007. Maize production is especially important in Central, Eastern and Southern provinces where, according to PHS, in 2007, 97% of all smallholder households grew maize and over 70% of all the land cultivated by smallholders was in maize.

Table 3.6: Percent of smallholders growing maize and mean area of maize planted for each province for years 2000 through 2007

		2000*	2001*	2002*	2003	2004	2005	2006	2007
FRA Maize Purchases (mt)		0	0	0	23,535	54,847	105,279	78,566	389,510
FSP Fertilizer Distributed (mt)		0	0	0	48,000	60,000	30,000	50,000	58,000
Central Province	% Smallholders Growing Maize	94.0%	94.7%	93.4%	92.5%	96.7%	98.7%	96.8%	97.8%
	Mean Area Planted (ha)	1.02	1.01	1.18	1.04	0.77	0.97	1.19	1.26
Eastern Province	% Smallholders Growing Maize	99.5%	99.6%	99.6%	97.2%	97.5%	98.8%	98.1%	97.1%
	Mean Area Planted (ha)	1.04	0.88	0.99	0.82	0.77	0.86	0.95	0.95
Southern Province	% Smallholders Growing Maize	96.3%	97.3%	96.9%	91.7%	90.9%	96.1%	94.8%	95.9%
	Mean Area Planted (ha)	1.40	1.56	2.06	1.21	0.93	1.21	1.20	1.49
Copperbelt Province	% Smallholders Growing Maize	91.9%	93.6%	91.4%	97.8%	95.8%	98.8%	99.2%	98.7%
	Mean Area Planted (ha)	1.32	1.00	1.04	0.94	0.71	0.89	0.91	0.82
Luapula Province	% Smallholders Growing Maize	33.5%	39.6%	38.8%	32.2%	30.9%	61.3%	62.2%	59.2%
	Mean Area Planted (ha)	0.30	0.27	0.30	0.33	0.26	0.30	0.35	0.30

Table 3.6 (cont'd)

Lusaka Province	% Smallholders Growing Maize	100%	99.1%	99.5%	99.9%	99.4%	99.5%	99.3%	99.1%
	Mean Area Planted (ha)	0.91	1.23	1.12	0.78	0.70	0.91	0.93	1.02
Northern Province	% Smallholders Growing Maize	46.0%	51.8%	59.3%	57.1%	51.8%	71.5%	71.8%	72.5%
	Mean Area Planted (ha)	0.62	0.49	0.56	0.47	0.46	0.51	0.64	0.55
Northwestern Province	% Smallholders Growing Maize	65.6%	88.4%	77.7%	76.0%	77.8%	94.4%	96.3%	94.0%
	Mean Area Planted (ha)	0.61	0.52	0.55	0.60	0.53	0.60	0.70	0.66
Western Province	% Smallholders Growing Maize	82.1%	95.6%	87.7%	88.0%	87.6%	93.0%	88.2%	96.7%
	Mean Area Planted (ha)	0.49	0.61	0.57	0.58	0.59	0.86	0.66	0.87

*denotes harvest years when FRA and FISP were both inactive
Source: Author's calculations from PHS data

The government has chosen to support maize production for several decades, but recently maize supports have increased dramatically through two main programs; FRA and FISP. Since the 2005 harvest year, FRA maize purchases and FISP subsidies have grown considerably. However, each program has had issues with implementation and each has caused some unintended effects. The most obvious effect of these programs – very much intended by government – has been to make maize relatively more attractive for smallholder households that can receive the benefits.

Since 2003, there is evidence that a higher percentage of Zambian smallholders are choosing to plant maize and that, in the main maize production provinces, smallholders are devoting more hectares of land to maize production. This increased devotion of resources to maize production among smallholders may lead to less land allocated to other crops, including cotton. This may pose a problem for Zambia's most important agricultural export, as the FRA and FISP supports may indirectly compete with cotton ginning companies for smallholders and their arable land.

4. CONCEPTUAL MODEL, ESTIMATION TECHNIQUES, AND RESULTS

4.1 Introduction

This chapter lays out our conceptual approach, the data we use, and the econometric techniques we employ to determine whether maize support policies in Zambia have negatively affected cotton cultivation. It then presents and discusses the empirical results.

To enhance the robustness of our conclusions, we use two independent data sets in the analysis. Using a household level panel collected in 2004 and 2008, we develop a Correlated Random Effects (CRE) Cragg two-stage model (Cragg, 1971). The other data set is a panel at the level of Standard Enumeration Area (SEA) but with independent random sampling of households within those SEAs each year; we pool two years of data from this data set and estimate the Cragg two-stage model using SEA level panel techniques.

4.2 Conceptual Model

Many analysts have used econometric models to analyze farmers' cropping area decisions – these studies are generally referred to as supply response models. The general theory of these models is that farmers adjust the crops they grow and the areas of land that they devote to each crop based on a series of factors. The factors used vary across studies, but often include the total area of land available and expected crop prices.

An important factor in our analysis is the level of government support to maize production, and our model follows Lidman and Bawden (1974) by including variables for government supports. The FRA and FISP supports to maize cultivation could adversely affect cotton production. In the maize chapter we explained how FRA and FISP supports make maize production more profitable and provide smallholders with a greater ability to sell their maize. We also show that mean land areas devoted to maize increased substantially in the cotton producing provinces during the 2005/06 and 2006/07 growing seasons (Table 3.6). This increased land devoted to maize during a period of rapid growth in maize supports could come from several sources: an increase in total area cultivated, a decrease in area devoted to crops other than cotton, or a decrease in cotton area. Our interest is in quantifying the latter.

While we take the most likely effect of maize supports on cotton areas to be negative, a positive effect is also possible. Cotton is most often rotated with maize and if a household received FISP fertilizer in any season and applied it to a maize field, they could have an incentive to utilize any residual fertilizer by planting cotton in the same field the following season. Thus, increased fertilizer distribution through FISP could encourage cotton cultivation in the following year.

To test for these relationships between maize supports and cotton, the general supply response model can be expressed as:

$$AC = f\,(HHC, PA, EP, GS, MA, SC) \tag{4.1}$$

Where	AC	is the area of cotton planted;
	HHC	is a vector of variables representing household characteristics;
	PA	is a vector of variables representing productive farming assets;
	EP	is a vector of variables representing expected crop output prices;
	GS	is a vector of variables representing government maize supports;
	MA	is a vector of variables representing market access;
	SC	is a vector of variables representing social connectivity.

The household characteristics vector contains variables that are frequently included in smallholder agricultural studies to account for the decisions the household makes. We expect that household decisions regarding cotton cropping are made by the head, so we include several variables to characterize the head of household.

We include a vector of productive farming assets because a household's agricultural asset level likely has a positive effect on area planted. Market access variables are relevant because a household may grow different crops based on their expectations of getting them to a market. The social connectivity vector is used to control for how well a household is connected to the power structure in their village, the idea being that a better connected family may have better access to FISP fertilizer and FRA maize sales among other things.

Expected crop prices are an important part of this study. It is well understood that crop prices can change significantly over the course of a growing season, but farmers' land allocations are fixed once they have planted their crops. Because farmers make their decisions on shares of land to devote to each crop several months before they sell any of their output, they make planting decisions based on what they think output prices will be at harvest time several months in the future. Economists model this uncertainty using "expectations models" which predict future prices or values based on present and past information. In Zambia, the quantity of maize that FRA plans to purchase from smallholders can change over the growing season as well, so this variable also requires that some kind of expectations process be specified.

In this paper we use naïve expectations for maize prices and for FRA purchases. We were unable to form any adaptive expectations models because they violate the assumption of strict exogeneity in our Cragg hurdle models (explained in section 4.5). Instead we use AMIC monthly retail maize prices from five regional markets in Eastern, Central and Southern provinces from the previous growing season to model farmers' expected maize prices. Farm level prices paid to farmers may not show the same relationship, but we cannot test for this relationship because we lack a full time series of farm level prices. For FRA purchases, households literally have no information other than the previous year's purchases on which to form expectations, as budgetary allocations for FRA are made only in January – after maize planting – and actual expenditures for FRA purchases have often changed dramatically (typically rising) over the course of the buying season.

We do not model cotton price expectations because minimum cotton output prices are announced by Dunavant prior to planting time, Dunavant has honored them during all but one year since liberalization, and other companies tend to behave as price followers, given Dunavant's dominant market position. We also do not model FISP fertilizer expectations: FISP fertilizer quantities are distributed prior to planting and despite some issues with late distribution discussed in section 2.2 we believe that the contemporaneous distributions are more important to households' planting decisions than are the distributions during previous seasons.

4.3 Data

We used data from two separate survey designs in our analysis. The designs, their benefits, and what we use them for are explained in this section

4.3.1 Supplemental Survey Panel Data

Zambia's CSO worked cooperatively with MSU to design and implement a supplemental survey in 2001 (SS01), 2004 (SS04), and 2008 (SS08). The surveys are called supplemental because the first one was executed as an additional interview to the same households following the 1999/2000 Post Harvest Survey.

Section 4.3.3 provides a description of the sampling process used for post harvest surveys. The survey sampled 6,922 households and covered all provinces and nearly all districts. The same households were sampled in each of the three rounds providing three period panel (or longitudinal) data. SS08 added additional randomly selected households to the original sample to "represent the current population of households at the time of the survey" (Megill, 2009), but we focus on the balanced sample common to all three years.

The questionnaire designs have been slightly modified each year, but the information obtained in all three surveys has for the most part been consistent. Information on household members, incomes, assets, crops planted, field areas, and harvest volumes among other characteristics were obtained in each of the three years.

4.3.2 Supplemental Survey Data Benefits

The main benefit of the supplemental surveys is that they are a household level panel. The benefits of using panel data in econometric analyses have been well studied and only a brief summary of these benefits is provided here; for a more complete discussion of the benefits of panel data see Wooldridge (2002). In many economic studies there is at least one factor that has a partial effect on the dependent variable for which no data is available. In agricultural studies of households, like this one, these factors can include household effort, motivation, and inherent farming ability. In this paper, we call these factors unobserved variables (or unobserved effects) because we have no observed data to create separate independent variables and estimate their partial effects. If these variables are correlated with any of our observed explanatory variables, then ignoring these "unobservables" can lead to omitted variable bias in coefficient estimations for the observed variables. The main benefit of panel data is that it can be utilized to control for the time constant unobserved effects and thus generate more accurate parameter estimates for the observed variables. For our detailed household level panel data, this means that factors like household ability and other effects that can be considered stable over time can be controlled for in estimation. A full description of our estimation with the supplemental survey data can be found in section 4.5.

4.3.3 Post Harvest Surveys

The CSO has designed and implemented a Post Harvest Survey (PHS) following every growing season since 1990/91, with a primary purpose of estimating the previous season's production of key crops. We have data for each of the surveys from 1992/93 through 2006/07, excluding the 1995/96 growing season. The PHS samples cover all of Zambia's nine provinces and nearly all of Zambia's districts. To obtain a random sample of households, districts were split into Census Supervisory Areas (CSA), each of which was split into several Standard Enumeration Areas (SEA). SEAs were randomly selected with focus on rural areas and smallholder households were randomly selected within each chosen SEA. Each PHS samples different households and most PHSs cover different SEAs. However, since 2002/03 each PHS has randomly sampled households from the same SEAs, thus generating a SEA level panel.

Unlike the supplemental surveys, there has been considerable variability in the PHS questionnaires. While each survey attempted to obtain a similar set of household information, including member characteristics, farming areas planted, and crop harvest volumes, the manner in which the information was obtained was not always consistent from year to year. This problem limited the years of PHS that we could use in our estimation, as described in section 4.5.

4.3.4 Post Harvest Survey Data Benefits

When the household data from the 2002/03 growing season forward are pooled, a SEA level panel can be created. Because the PHS panel is at the SEA level, not the household level, household level unobservable effects cannot be accounted for with econometric techniques: only unobservable effects of each SEA (e.g., agro-ecological potential, proximity to markets, perhaps the overall motivation or ability of farmers in the area, and others) can be controlled for in estimations. Different panel data estimation techniques were employed for the pooled PHS data set. Another major benefit of the PHS data is that it provides an opportunity for us to approach our research objectives with two separate estimations and techniques and two entirely independent data sets, resulting in more robust conclusions.

4.4 Model Specification

Many smallholder households chose not to grow cotton in the represented years. In our SS panel sample, 994 of the 1,927 households cultivated cotton in at least one of the two harvest years – 2003 and 2007. In modeling the effects of maize supports on smallholders' decisions to plant cotton, the distribution of the dependent variable – hectares planted in cotton – 'piles up' at zero, because 74% of the households observed did not plant any cotton in the given season. These situations where data for the dependent variable pile up at some point – usually zero – are called limited dependent variable models (Wooldridge, 2002) and are common in economic and agricultural studies.

Estimating a model with a limited dependent variable by ordinary least squares (OLS) would create an inefficient linear estimation of cotton area planted. Treatment of the problem with OLS will more than likely estimate a negative area planted in cotton for some smallholder households which is not a possible outcome as areas are strictly positive. The tobit model is often employed in these cases and it offers a maximum likelihood estimation procedure that accounts for such restrictions.

The tobit model assumes a limit in the dependent variable at some value – in this model the limit is zero – and a continuous and normal distribution of values beyond that limit. In this case a nontrivial proportion of the sample planted zero hectares of cotton, but among those households that chose to plant cotton the distribution of hectares planted can be thought of as continuous. Furthermore, households that planted zero hectares of cotton are important observations in this study, because they imply that the household chose not to plant cotton. The tobit model includes these important observations in its estimations whereas other econometric techniques treat the zeros as a missing data problem.

The tobit model has two key limitations. One limitation is that estimation of the model produces only one set of parameter coefficients. This is a limitation because we want to analyze the effects of maize supports on both the farmers' decisions whether or not to plant cotton and also on what hectarage to plant in cotton given that they decided to plant it. Estimation of the tobit model yields only one set of coefficients and only the overall partial effects (combining the decision whether or not to plant and the decision of how much to plant). Yet in this study we are also interested in the conditional partial effects – the effects on each of these separate decisions. The second limitation of the tobit is that it estimates the dependent variable by a single set of right hand side variables. This condition implies that both the participation decision (first stage) and the amount decision (second stage) are determined by the same set of right hand side variables. In many cases, it is useful and often more accurate to allow the two different decisions to be determined by two different sets of factors. In this particular instance we argue that both stages are affected by the same factors, so the same set of explanatory variables are used for both stages in estimation.

4.4.1 Cragg Hurdle Model and Partial Effects

The Cragg hurdle model was created out of the tobit estimation process to handle both of the above stated problems. The tobit model is nested within the Cragg hurdle model in such a way that the tobit is a special case of the Cragg (Wooldridge, 2002). The Cragg model splits the tobit into a two-stage model that includes an estimation of participation followed by an estimation of quantity conditional on participation. In this case, the first stage will model the smallholders' decisions to plant cotton or not and the second stage will model the area farmers decide to plant given that they chose to grow cotton. Following the example used by Mather, Boughton, and Jayne (2009) and the notation used by Wooldridge (2002) the two stages of the Cragg hurdle model can be expressed as:

Stage 1 $\qquad S_{it}^* = \beta_1 x_{1t} + e_i \qquad e_i \sim N(0, \sigma^2) \qquad$ (4.2a)

$\qquad$ where $S_i = 1$ if $S_i^* > 0$, otherwise $S_i = 0$,

Stage 2 $\qquad W_{it}^* = \beta_2 x_{2t} + u_i \qquad u_i \sim N(0, \sigma^2) \qquad$ (4.2b)

$\qquad$ where $W_i = W_i^*$ if $W_i^* > 0$ and $S_i = 1$, otherwise $W_i = 0$,

S_{it}^* is the latent variable of S_{it} which is the observed binary variable representing a household's decision to plant cotton or not. W_{it}^* is the latent variable of W_{it} which is the observed continuous variable of actual land area planted in cotton. The subscripts *i* and *t* refer to the *i*th household during time period *t*. β_1 and β_2 are vectors of estimated parameters from their respective variable vectors x_{1t} and x_{2t}.

An additional assumption required for this two stage model is D(W*|S, x) = D(W*| x), which means that the processes that determine W* and S are independent (Wooldridge, forthcoming) or that there is no correlation between the error terms, e_i and u_i (Mather, Boughton, and Jayne, 2009). Furthermore, in the above equations, x_{1t} and x_{2t} need not contain the same set of explanatory variables.

There are a few different partial effects that can be calculated out of this two stage model. The effects are differentiated by being "unconditional" or "conditional" on the binomial decision variable. Conditional partial effects are the partial effects of a variable, x_j, in only one of the two stages; x_j will have a different conditional partial effect in stage one and in stage two, if x_j is included in both estimation stages. The unconditional partial effect of x_j takes into account both stages of the model regardless of whether or not x_j is in both stages or only one stage. In essence, the unconditional partial effects of x_j examine x_j's partial effect on the process as a whole, while the conditional partial effects of x_j look only at x_j's partial effect on each individual stage of the model. Following Burke's (2009) example, the conditional partial effect of x_j in the first stage is:

$$\frac{\partial P(W > 0 \mid x_1)}{\partial x_j} = \beta_{1j}\phi(x_1\beta_1) \tag{4.3}$$

where β_{1j} is the maximum likelihood estimated coefficient of x_j from the probit, and ϕ is the standard normal probability density function (pdf). The conditional partial effect of x_j in the second stage is:

$$\frac{\delta E(W_i | W_i > 0, x_{2i})}{\delta x_j} = \beta_{2j}\left(1 - \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\left(\frac{x_2\beta_2}{\sigma} + \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\right)\right) \tag{4.4}$$

where λ represents the inverse mills ratio[5], β_{2j} is the estimated coefficient of x_j from the truncated regression and σ is the estimated variance from the truncated regression.

Calculating the unconditional partial effects from the two estimation stages is more complicated and can be expressed as a single equation with two parts:

$$\frac{\delta E(W | x_1, x_2)}{\delta x_j} = \beta_{1j}\varphi(x_1\beta_1)\cdot\left(x_2\beta_2 + \sigma\cdot\lambda\left(\frac{x_2\beta_2}{\sigma}\right)\right) + \Phi(x_1\beta_1)\cdot\beta_{2j}\left(1 - \lambda(x_2\beta_2/\sigma)\left(x_2\beta_2/\sigma + \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\right)\right) \tag{4.5}$$

[5] The inverse mills ratio (IMR) is the probability density function divided by the cumulative density function (pdf / cdf).

where Φ is the cumulative density function. The average partial effects (APEs) are obtained by averaging x_j's partial effects across all observations. Conditional and unconditional APEs are reported in our results.

4.5 Estimation and Results

This study employs two separate Cragg hurdle models to address our research questions with more confidence. Both models follow the typical Cragg two stage estimation process, employing a probit regression for the first stage and a truncated normal regression for the second stage. Different panel data are used for the two models, and the actual estimation procedures are modified to meet the needs of the data and panel estimation techniques. These techniques and their respective results are explained in this section.

4.5.1 Model 1: SS Household level Panel Data for Harvest years 2003 and 2007

4.5.1.1 *Variables*

The household level panel Cragg model uses the supplemental survey panel data discussed in section 4.3.1. However, there are a few discrepancies in the information obtained in the three panel years. SS01 differs from SS04 and SS08 in the way it identifies household members: the two latter implementations of the panel collect information on all household members, but SS01 collected detailed data for "adults" only (age 12 and up), making calculations of household size and dependency ratios difficult. SS01 also does not obtain information on ownership of animal traction and it calculates household asset values using a smaller set of productive assets. Because we view animal traction ownership and productive asset values as important factors in a household's planting decision, we use only SS04 and SS08 in our estimations, providing data on harvest years 2003 and 2007. Table 4.1 shows our complete list of variables used in both stages of our first Cragg model along with a brief description of each.

Table 4.1: Variable names and definitions

Variable	Definition
tot_hect	total cultivated land area (hectares)
animal_trac	ownership of animal traction dummy
mech_trac	ownership of mechanical traction dummy
age_hd	age of household head
educ_hd	education of household head (years)
fem_hd	dummy variable for female head of household
dep_ratio	(number of household members age<15, age>60) / (number of household members 15<age<60)
hhlabor	number of household members, 15<age<60
yr_0607, yr_0506	year dummy
fisp_mt	metric tons of FISP fertilizer received this growing season by each district (actual reported)
fisp_ratio	percentage of households that received FISP fertilizer this growing season as a decimal (e.g., 14.2% = .142)
FRA_1	FRA district level maize tons purchased in the previous growing season (from FRA)
FRA_2	FRA district level maize tons purchased in the previous growing season / number of district HHs in the same year
Cot_price	announced pre-planting price per KG of cotton
MZ_price	province level median prices received by farmers per KG of maize in the previous growing season
Eastern Prov	Eastern province dummy
Southern Prov	Southern province dummy
hdman1	dummy variable for any household member connected to the village headman
past0408	value of productive assets
dist_vt	distance to vehicular transport, district reported medians

Source: Supplemental survey data (SS08 and SS04)

Our definition of "tot_hect" as the area of cropland owned by the household excludes virgin and fallow land areas that the household owns. This definition is consistent with the definition used by Xu et al (2009). The variable was defined this way because the SS04 data do not contain size information for fallow fields. However, excluding fallow fields from our land area owned variable will not likely impact our results. An analysis of the SS08 data for the households used in our study indicated that definitions of land owned with and without fallow field areas were highly correlated (.80) and the median and mean difference between the two definitions were very small, zero hectares and 0.6 hectares respectively.

Because this paper is interested in the effects of maize support programs on smallholder planting decisions, further discussion is needed for the FRA and FISP policy variables. Table 4.1 shows two FISP variables ("fisp_mt" and "fisp_ratio") and two FRA variables ("FRA_mt" and "FRA_ratio"). We estimated our models four times – once for each combination of FRA and FISP variables. The first FRA variable, "FRA_mt", was defined as the total metric tons of maize purchased by the FRA in the previous growing season at the district level. This definition captured some district level naïve expectations of FRA maize purchases for the estimated growing seasons. The same expected FRA involvement was applied to every household within a district. The second FRA variable, "FRA_ratio", was defined as the number of metric tons of maize purchased by the FRA from the previous year's harvest in each district divided by the estimated number of households in the same district. This variable is the household average quantity of maize sold to the FRA for each district during the previous growing season. This definition also captured some district level naïve expectations, but the expectations captured were based on the per household FRA purchases in each district. All estimates used in the calculation of these variables were obtained from the PHS data, since it was implemented each year.

Because most FISP fertilizer is delivered prior to planting, farmer expectations did not need to be modeled. PHS data on FISP fertilizer receipts during the contemporaneous season were used in estimations. However, we had to be careful in defining our variables. Actual FISP fertilizer received at the household level would be the most accurate way of defining the variable, however it would be highly correlated with our area of cultivated land variable as decisions of areas to plant and fertilizer quantities to purchase from FISP are likely made concurrently. In light of this potential multicollinearity problem, we defined our FISP variables using the contemporaneous PHS data but we aggregated them to the district level. The first FISP variable, "FISP_ratio", was defined as the percentage of households that actually received FISP fertilizer in the contemporaneous growing season by district. This variable captured the district level probability that a household was able to obtain FISP fertilizer for that season. The second FISP variable, "FISP_mt", was defined as the metric tons of FISP fertilizer received by district. This definition more accurately captured the amount of FISP fertilizer released in each district, but it did not capture the number of households that received it.

4.5.1.2 *Estimation*

Model 1 uses a correlated random effects (CRE) probit model (Wooldridge, 2002) for the first stage. Traditional random effects probit models work under the assumption that the unobservable effects (c_i) and the explanatory variables (x_i) are independent, but we expect that the unobservable effects, like household effort, ability and motivation, are related to x_i. Chamberlain (1980) introduced a technique that allowed for correlation between x_i and c_i by allowing c_i to be a function of the time means of x_i. We use Mundlak's (1978) version of Chamberlain's approach. The general form was expressed by Wooldridge (2002) as:

$$c_i = (\psi + \bar{x}_i \xi + a_i) \quad , \tag{4.6}$$

where $\bar{x}_i$ are time means of each explanatory variable for every household. The relationship assumes that c_i are constant across time for each household and, therefore, the effects of c_i on x_i will be partially explained by the time constant $\bar{x}_i$. The actual assumption used by Mundlak (1978) is that the distribution of c_i given x_i is normal and a function of $\bar{x}_i$.

In estimation, time means are added to the list of explanatory variables. They are, by definition, constant over time, but there is a great deal of variability across households, which allows their effects to be estimated. Variables that are the same for each household (e.g., time dummies) are excluded from $\bar{x}_i$. The time means differentiate a CRE probit from a pooled probit by controlling for those unobserved effects that are distributed as in equation 4.6 and that are constant over time: any unobserved factor that varies across time for any household or that is not distributed as in 4.6 is not controlled for in the CRE probit.

The second stage of our model is executed with a CRE truncated regression. A truncated regression is a linear estimation of parameters with a dependent variable that is limited at some value. As discussed above, this limit is zero in our case, because many households did not plant cotton. Our truncated regression is estimated on only the households with greater than zero hectares of cotton planted. As in the CRE probit, a vector of time means is added to the list of independent variables to control for any time constant unobserved heterogeneity. Our two stage model can be generally written as:

Stage 1 $$P(S_i = 1 | x_i) = \beta_1 x_i + \alpha_1 \bar{x}_i + \varepsilon_i \tag{4.7}$$

Stage 2 $$W_i = \rho + \beta_2 x_i + \alpha_2 \bar{x}_i + u_i \tag{4.8}$$

Where S_i is the decision to plant, equal to 1 if the household chose to plant cotton and equal to 0 otherwise, and

W_i is the area of cotton planted;

x_i is the set of all explanatory variables common to both stages;

$\bar{x}_i$ is the set of household time means of x_i;

ρ is the constant intercept estimated in stage 2;

β_1 is the set of coefficients estimated on x_i in stage 1;

β_2 is the set of coefficients estimate on x_i in stage 2;

α_1 is the set of coefficients estimated on $\bar{x}_i$ in stage 1;

α_2 is the set of coefficients estimated on $\bar{x}_i$ in stage 2.

The CRE probit and the CRE truncated regression require the additional assumption of strict exogeneity. Strict exogeneity is expressed by Wooldridge (2002) with the following statement:

$$E(y_{it} | x_{i1}, x_{i2}, ..., x_{iT}, c_i) = E(y_{it} | x_{it}, c_i) = x_{it}\beta + c_i \tag{4.9}$$

for $t = 1,2,\ldots,T$.

This means that, once all of the explanatory variables and the unobserved effects are accounted for, no other factors in the current or any past time periods have any partial effect on the dependent variable. Wooldridge (2002) emphasizes that strict exogeneity also implies that the explanatory variables in any given time period are uncorrelated with the error terms in every time period. In our case, we cannot include past cropping decisions in our explanatory variables, because lagged dependent variables directly violate the strict exogeneity assumption.

The Cragg hurdle model with the Mundlak-Chamberlain device reports valid estimations of coefficients, which we use to obtain the average partial effects (APEs) of each variable. However, the method does not report valid standard errors. So, we employed a bootstrapping routine with 500 iterations to repeatedly resample our data and estimate valid standard errors.

4.5.1.3 *Model 1 Results*

The estimated results of Model 1 are shown in Tables 4.2, 4.3, and 4.4. Table 4.2 displays the conditional partial effects on the first stage of Model 1 on a household's decision to plant cotton or not: Table 4.3 shows the conditional partial effects on the second stage on what area a household decided to plant in cotton given that they decided to plant it: and Table 4.4 displays the unconditional partial effects on both stages on the area of cotton planted. The model estimations were limited to include only the observations from SEAs that had at least one household that planted cotton in each of the 2002/03 and 2006/07 growing seasons. This ensures that the households whose data were used in estimation were more likely to have had the option to plant cotton than the households whose data were excluded.

Table 4.211: First stage conditional APEs, CRE Cragg

	FRA_mt						FRA_ratio					
	FISP_mt			FISP_ratio			FISP_mt			FISP_ratio		
Variable	APE	SE	sig	APE	SE	sig	APE	SE	sig	APE	SE	sig
tot_hect	0.057609	0.014818	***	0.057082	0.014863	***	0.056707	0.014746	***	0.055647	0.014638	***
animal_trac	-0.024944	0.027410		-0.024295	0.027143		-0.022918	0.028061		-0.023285	0.028081	
mech_trac	-0.397083	0.046927	***	-0.396787	0.047140	***	-0.396758	0.046346	***	-0.396825	0.046497	***
ag_hd	0.002591	0.002200		0.002617	0.002258		0.002668	0.002237		0.002730	0.002338	
educ_hd	0.003871	0.011294		0.002139	0.011345		0.003469	0.011265		0.000631	0.011216	
fem_hd	-0.089877	0.033935	***	-0.090703	0.033710	***	-0.090100	0.033747	***	-0.092289	0.033566	***
dep_ratio	-0.014133	0.016879		-0.013959	0.017092		-0.014111	0.016978		-0.013919	0.017366	
hh_labor	0.014321	0.013278		0.013222	0.013145		0.014952	0.013170		0.013273	0.013111	
yr_0607	0.312013	0.153516	**	0.266157	0.164203		0.336100	0.140727	**	0.281655	0.156059	*
FISP	0.000049	0.000033		0.155631	0.635045		0.000070	0.000034	**	0.174870	0.658654	
FRA	0.000006	0.000003	**	0.000007	0.000003	***	0.035497	0.072280		0.027784	0.078361	
Cot_price	-0.004040	0.002436	*	-0.003241	0.002413		-0.004103	0.002417	*	-0.002899	0.002386	
MZ_price	0.000542	0.000305	*	0.000555	0.000322		0.000418	0.000319		0.000376	0.000356	
past0408	0.006639	0.003755	*	0.006797	0.003775	*	0.006702	0.003728	*	0.007040	0.003756	*
dist_vt	0.000007	0.004574		0.001024	0.004739		-0.000612	0.004848		0.000682	0.005198	
Eastern Prov	0.123913	0.062738	**	0.129029	0.066854	*	0.138834	0.062703	**	0.152945	0.060429	**
Southern Prov	-0.098383	0.063900		-0.096470	0.065251		-0.105974	0.067885		-0.104004	0.069246	
hdman1	0.041638	0.033225		0.041288	0.032967		0.041318	0.033488		0.041671	0.033019	

Source: Author's calculations from supplemental survey data (SS08 and SS04)

Table 4.3: Second stage conditional APEs, CRE Cragg

	FRA_mt						**FRA_ratio**					
	FISP_mt			**FISP_ratio**			**FISP_mt**			**FISP_ratio**		
Variable	APE	SE	sig	APE	SE	sig	APE	SE	sig	APE	SE	sig
tot_hect	0.315581	0.032715	***	0.315313	0.032685	***	0.315600	0.032559	***	0.315505	0.032560	***
animal_trac	-0.090738	0.050313	*	-0.090319	0.050311	*	-0.091009	0.050622	*	-0.091780	0.051505	*
mech_trac	-2.142296	0.277071	***	-2.143624	0.276006	***	-2.124706	0.272910	***	-2.120210	0.271634	***
ag_hd	-0.004280	0.005083		-0.004233	0.005151		-0.004126	0.005031		-0.004153	0.005016	
educ_hd	-0.015110	0.026165		-0.013771	0.025553		-0.016826	0.026855		-0.016102	0.026322	
fem_hd	-0.200385	0.073985	***	-0.201143	0.074856	***	-0.194381	0.072696	***	-0.194153	0.073337	***
dep_ratio	-0.019380	0.042576		-0.020384	0.042340		-0.019831	0.042148		-0.020578	0.041857	
hh_labor	-0.022484	0.019609		-0.021669	0.019515		-0.021423	0.019346		-0.021419	0.019326	
yr_0607	-0.232510	0.406904		-0.174957	0.409222		-0.221170	0.410606		-0.184586	0.407596	
FISP	-0.000022	0.000031		-0.434121	0.817057		-0.000015	0.000035		-0.366122	0.837265	
FRA	0.000001	0.000004		0.000001	0.000004		0.085635	0.108659		0.080628	0.111056	
Cot_price	0.001937	0.003362		0.001345	0.003388		0.001698	0.003435		0.001306	0.003371	
MZ_price	0.000764	0.000558		0.000730	0.000572		0.000932	0.000585		0.000920	0.000596	
past0408	-0.006206	0.008192		-0.006025	0.008313		-0.006683	0.007998		-0.006437	0.008091	
dist_vt	0.003727	0.006751		0.003076	0.006582		0.004175	0.006623		0.003820	0.006473	
Eastern Prov	0.163734	0.103676		0.179337	0.098969	*	0.139162	0.099945		0.134924	0.092804	
Southern Prov	0.022694	0.094970		0.019372	0.097517		0.036399	0.096036		0.039974	0.097527	
hdman1	-0.075741	0.046711		-0.074828	0.047623		-0.073853	0.046458		-0.074615	0.047287	

Source: Author's calculations from supplemental survey data (SS08 and SS04)

Table 4.4: Unconditional APEs, CRE Cragg

	FRA_mt						FRA_ratio					
	FISP_mt			FISP_ratio			FISP_mt			FISP_ratio		
Variable	APE	SE	sig	APE	SE	sig	APE	SE	sig	APE	SE	sig
tot_hect	0.169082	0.018303	***	0.168561	0.018315	***	0.168325	0.018205	***	0.167554	0.018218	***
animal_trac	-0.107031	0.053923	**	-0.106192	0.053855	**	-0.105955	0.054227	*	-0.106965	0.054883	*
mech_trac	-0.452475	0.178616	**	-0.453596	0.178847	**	-0.451968	0.175138	**	-0.452166	0.175606	***
ag_hd	0.000155	0.002386		0.000193	0.002363		0.000271	0.002459		0.000304	0.002416	
educ_hd	-0.003281	0.012355		-0.004000	0.012148		-0.004268	0.012483		-0.006036	0.012290	
fem_hd	-0.243448	0.083563	***	-0.244433	0.083748	***	-0.238031	0.081749	***	-0.238906	0.081797	***
dep_ratio	-0.018077	0.021710		-0.018350	0.021810		-0.018223	0.021561		-0.018384	0.021758	
hh_labor	0.001333	0.012143		0.000860	0.012177		0.002203	0.012106		0.000981	0.012205	
yr_0607	-0.030778	0.448336		0.003546	0.443962		-0.001875	0.449403		0.004812	0.440263	
FISP	0.000027	0.000026		-0.062074	0.538138		0.000045	0.000029		-0.020923	0.565762	
FRA	0.000005	0.000003	*	0.000005	0.000003	*	0.060251	0.069414		0.052648	0.071805	
Cot_price	-0.002153	0.002376		-0.001810	0.002342		-0.002290	0.002377		-0.001574	0.002312	
MZ_price	0.000701	0.000306	**	0.000697	0.000322	**	0.000679	0.000330	**	0.000643	0.000358	*
past0408	0.002319	0.004359		0.002504	0.004423		0.002164	0.004304		0.002506	0.004364	
dist_vt	0.001508	0.004804		0.001983	0.004915		0.001239	0.005011		0.002035	0.005255	
Eastern Prov	0.236920	0.117089	**	0.253819	0.115928	**	0.223873	0.113192	**	0.228991	0.106709	**
Southern Prov	-0.053281	0.095415		-0.054573	0.099346		-0.047681	0.097245		-0.043069	0.100788	
hdman1	-0.045079	0.061052		-0.044426	0.060955		-0.043445	0.060237		-0.043954	0.059990	

Source: Author's calculations from supplemental survey data (SS08 and SS04)

Our FISP variables are insignificant in all models for all stages save the unconditional APE on FISP when it is defined in metric tons and estimated with the FRA variable defined in ratio form. However, the APE is positive in this instance. Our FRA variable is significant in the first stage and the conditional calculation, under both specifications of FISP, when FRA is defined in metric tons. Like our results on FISP, these significant APEs on FRA are all positive.

The fact that eleven of the possible sixteen APEs of both maize support measures are insignificant and that all five of the significant APEs were positive suggests that the increased land area to maize comes from a source other than cotton area. While we have presented a case where the effect of FRA maize purchases on cotton production could be positive, the positive and significant APEs of our FRA variables are still surprising. We did not expect the potential impact to be strong enough to show significance in our model. We provide evidence in support of our FRA and FISP variables in section 4.6.

The land area owned and cultivated APEs are positive and significant at the 1% level for all stages of every model. The APEs are similar for all of the models; the unconditional APEs suggest that a one hectare increase above the mean in land area cultivated leads to a 0.17 hectare increase in the area of cotton planted. These results are logical, as households with more land are more likely to plant cotton and a household is likely to plant a greater area in cotton when they have more land available to cultivate.

The head of household being female has strong negative unconditional APEs that are significant at the 1% level for all four models. The unconditional APEs suggest that a female head of household corresponds with about 0.24 fewer hectares planted in cotton at the average. Also having a strong, significant and negative unconditional effect in all models is ownership of mechanical traction. This result can partially be explained by households with mechanical traction having a wider choice set of crops than most households, including the ability to farm wheat and other profitable crops. Like ownership of mechanical traction, ownership of animal traction shows negative and significant (at the 10% level) unconditional APEs for all four estimations. These surprising results suggest that owning animal traction leads to a decrease in cotton area planted of around 0.11 hectares, which is not a realistic depiction of the relationship between animal traction and cotton production[6]. We take the results of the animal traction variable obtained in Model 2 estimations (given in Tables 4.6, 4.7 and 4.8) to be more accurate.

<u>4.5.2 Model 2: PHS SEA Level Panel Data for Harvest Years 2003 and 2006</u>

4.5.2.1 *Variables*

The second model uses the PHS data discussed in section 4.3.3. As discussed in that section, the data for the 2002/03 growing season and each season after can be pooled to form an SEA level panel. However, in our attempt to define variables comparable to those used in our CRE Cragg (Table 4.1), we found that the information obtained in several of the surveys restricted which seasons of the PHS we could use in our pooled estimation.

A full list of desired variables and their availability from each round of the PHS following 2002/03 is found in Table 4.5. Ultimately, we decided to include only variables that we could define in the same way that we did for Model 1. With these definitions we included only the PHSs for the 2002/03 and the 2005/06 growing seasons. We were able to define every relevant variable in the 2004/05 PHS except the naïve maize price variable. The 2003/04 PHS

[6] The data used in estimations of Model 1 show that households with animal traction were both more likely to have planted cotton and planted it in a larger area than those households that did not own animal traction (significant at the 1% level). This information coupled with observations and experiences in Zambia makes the negative and significant unconditional APEs of our animal traction ownership variable seem unrealistic.

Table 4.5: Availability of variables in PHS

	PHS Growing Seasons				
Variable	2002/03	2003/04	2004/05	2005/06	2006/07
cotton dummy	Y	Y	Y	Y	Y
cotton area planted	Y	Y	Y	Y	Y
maize dummy	Y	Y	Y	Y	Y
maize area planted	Y	Y	Y	Y	Y
total land area cultivated	Y	Y	Y	Y	Y
female head of HH dummy	Y	Y	Y	Y	n
age of HH head	Y	Y	Y	Y	n
education of HH head	Y	n	Y	Y	n
HH labor	Y	n	Y	Y	n
dependency ratio	Y	n	Y	Y	n
*value of productive assets	n	n	n	n	n
ownership of animal traction dummy	Y	n	Y	Y	n
ownership of mech. traction dummy	Y	n	Y	Y	n
*distance to vehicular transport	n	n	n	n	n
*related to village chief dummy	n	n	n	n	n

* denotes variable not included in estimation
Source: PHS data sets implemented by CSO

did not obtain prices received by farmers, so we cannot define maize price in a way that is consistent with Model 1. If we allowed flexibility across models in the way some of the variables were defined we could create a pooled file with more than two seasons, but we emphasize consistency in variable definition across both of our models so we can more accurately compare results.

We were not able to include all of the variables from Model 1 in Model 2. Most notably, the value of productive assets is missing from Model 2 because none of the PHSs obtained similar information. We created the most comparable and consistent set of variables that we could out of the data we have.

4.5.2.2 *Estimation*

Our second model uses the same basic Cragg model discussed in detail for Model 1. The differences between the two estimations revolve around the data used and, specifically, the required assumptions about the unobserved effects, c_i.

Model 2 uses a pooled SEA level panel and, therefore, the c_i are assumed to be at the SEA level. Possible sources of unobserved effects at this level that might affect household planting decisions include but are not limited to market access, proximity to FRA selling depots, soil and climate related agricultural potential, and the degree of cotton ginnery support to the area. We assume these c_i to be constant over time and across all households within each SEA.

The assumption of strict exogeneity, expressed in equation 9, is required in Model 2 as well. But it is not a major concern because we have no reason to believe that our included variables might violate that assumption. Estimation of Model 2 does not require Mundlak's version of Chamberlain's approach as used in Model 1, because our fixed effects technique allows for direct correlation between c_i and x_i and, therefore, no further assumptions need to be made about their relationship. Instead of including time means of all the variables in the regressions, SEA dummy variables are used to control for c_i. These dummies capture any constant and common effects of the households within each SEA. If our assumptions about c_i are valid, the SEA dummies will sufficiently control for the unobservable effects and our Cragg model estimation will yield more unbiased parameter estimates for the observed variables.

What we have created, then, is an SEA level clustered panel where several households are grouped under each SEA, where we account for c_i in each SEA using a fixed effects technique of including a complete set of SEA dummies. The number of households within each cluster varies across SEAs, but Wooldridge (2002) notes that "different cluster sizes cause no problem," (pp 330) and that the fixed effects properties would hold if the number of clusters is large relative to the number of households in each cluster. This is certainly true in our case, as our estimations include 330 clusters, most of which have about 20 households and none of which has more than 59.

A more serious threat to Model 2 is posed by the "incidental parameters problem". This problem occurs when c_i is estimated along with the coefficients in most maximum likelihood estimations and leads to biased and inconsistent estimations of the parameters. Greene (2004) found evidence of biased and inconsistent parameters from fixed effects probits and fixed effects truncated regressions, both of which are employed by our Cragg model.

However, we are directly interested in the APEs, not the estimated coefficients themselves. The question of how a fixed effects technique impacts the APEs is called by Wooldridge an "interesting, and apparently open, question" (pp 489, 2002). He goes on to suggest that the APEs obtained from a fixed effects probit "could have reasonable properties" (pp 489, 2002). Greene (2004) finds that biases in the APEs are "far less than those in the coefficient estimators" (pp 137). He, too, was unable to make a concrete conclusion about the APEs resulting from fixed effects models, offering the following:

> "The question does remain, should one use this technique? It obviously depends on T and the model in question. The reflexive negative reaction, however, because it is "biased and inconsistent" neglects a number of considerations, and might be ill advised if

the alternative is a misspecified random effects model, a pooled estimator which neglects the cross unit heterogeneity, or a semiparametric approach which sacrifices most of the interesting content of the analysis in the interest of 'robustness'" (pp 145).

While our fixed effects estimation techniques may suffer from the incidental parameters problem, the effects on calculations of the APEs are unknown and possibly small. Thus, we judge that the gain from addressing our core question with a second data set (and the best methods available to apply to it) justifies its inclusion in this case.

4.5.2.3 *Model 2 Results*

Tables 4.6, 4.7, and 4.8 show the results of our pooled fixed effects Cragg model estimations following the same format as Model 1's results. Here we notice that our maize policy variables show no significance in any stages of any of the estimated models. Taken together with Model 1 – statistically significantly parameters in only 5 out of 16 possibilities – these results suggest little if any meaningful effect of the maize supports on cotton plantings, meaning that the increased areas planted in maize likely came from a source other than a decrease in areas planted in cotton.

As in Model 1, total land area cultivated and the dummy for female head of household both have important and significant unconditional APEs with their anticipated signs. Unlike Model 1, ownership of animal traction is positive and significant (at the 5% level) in all of the first stage conditional APEs and in all of the unconditional APEs. The results suggest that households that owned animal traction were about 5% more likely to have planted cotton and planted about .13 more hectares of cotton at the average. This result is not surprising, as ownership of animal traction could be a good indicator of a farmer's ability and also allows more land to be cropped. The difference in result for this variable across models – negative and significant in Model 1 and positive and significant in Model 2 – is at least partially explained by the lack of a productive asset value variable in Model 2, as the animal traction dummy is partly picking up these effects in this latter model. We take the results yielded by Model 2 estimations to be a more accurate portrayal of the real relationship between animal traction ownership and cotton cultivation in Zambia.

In both models, we observe more significant APEs in the first stage and in the unconditional two stage effects and fewer significant APEs in the second stage conditional effects. This is consistent with results from Figure 2.4, which shows that mean areas planted to cotton are relatively stable across years. As analyzed in great detail in chapter 2, movements into and out of cotton production are much more important drivers of aggregate production than are changes in mean area planted. That is why we see more significant effects on households' decisions to plant cotton.

Table 4.6: First stage conditional APEs, Fixed Effects Cragg model

	FRA_mt						FRA_ratio					
	FISP_mt			FISP_ratio			FISP_mt			FISP_ratio		
Variable	APE	SE	sig	APE	SE	sig	APE	SE	sig	APE	SE	sig
tot_hect	0.061974	0.005853	***	0.062061	0.005916	***	0.06199	0.005807	***	0.062081	0.006033	***
animal_trac	0.051890	0.021591	**	0.050938	0.021510	**	0.05226	0.021592	**	0.051205	0.018703	***
mech_trac	-0.075075	0.100155		-0.076566	0.098404		-0.0776	0.099728		-0.078890	0.104119	
ag_hd	-0.002447	0.000484	***	-0.002459	0.000482	***	-0.0024	0.000481	***	-0.002461	0.000510	***
educ_hd	-0.001771	0.001370		-0.001766	0.001382		-0.0018	0.001376		-0.001781	0.001299	
fem_hd	-0.088763	0.018061	***	-0.089022	0.017989	***	-0.0886	0.018023	***	-0.088924	0.019270	***
dep_ratio	-0.004655	0.007884		-0.004689	0.008124		-0.0046	0.008081		-0.004675	0.008539	
hh_labor	0.013113	0.005016	***	0.013052	0.005056	***	0.0131	0.005041	***	0.013040	0.005978	**
yr_0506	-0.159834	0.183667		-0.183360	0.178320		-0.1556	0.184632		-0.178963	0.153076	
FISP	0.000014	0.000019		0.316568	0.289293		1.3E-05	0.000018		0.321153	0.289006	
FRA	0.000020	0.000016		0.000019	0.000016		0.77998	0.635055		0.773253	0.505818	
Cot_price	0.001291	0.001141		0.001481	0.001164		0.00125	0.001156		0.001442	0.001009	
MZ_price	0.000200	0.000426		0.000063	0.000418		0.00023	0.000444		0.000094	0.000334	

Source: Author’s calculations from PHS data

Table 4.7: Second stage conditional APEs, Fixed Effects Cragg model

	FRA_mt						**FRA_ratio**					
	FISP_mt			**FISP_ratio**			**FISP_mt**			**FISP_ratio**		
Variable	APE	SE	sig	APE	SE	sig	APE	SE	sig	APE	SE	sig
tot_hect	0.189531	0.011574	***	0.188913	0.011814	***	0.18953	0.01156	***	0.188914	0.011885	***
animal_trac	0.004233	0.030426		0.006341	0.030317		0.00438	0.03028		0.006362	0.026875	
mech_trac	-0.518492	0.318474		-0.503995	0.306889		-0.518	0.30571		-0.503659	0.345450	
ag_hd	-0.003022	0.000959	***	-0.002935	0.000958	***	-0.003	0.00096	***	-0.002934	0.001085	**
educ_hd	0.000871	0.002143		0.000819	0.002170		0.00085	0.00215		0.000813	0.002232	
fem_hd	-0.114438	0.049405	**	-0.115865	0.050098	**	-0.1142	0.04983	**	-0.115797	0.053448	*
dep_ratio	-0.034994	0.015506	**	-0.035372	0.015538	**	-0.0351	1.58E-02	*	-0.035403	0.015397	**
hh_labor	-0.015370	0.010060		-0.015162	0.009953		-0.0154	0.01002		-0.015189	0.009004	
yr_0506	0.273492	0.408346		0.262871	0.410194		0.27094	0.40766		0.260253	0.421004	
FISP	0.000031	0.000039		-0.094145	0.481656		3.1E-05	3.9E-05		-0.094035	0.478922	
FRA	0.000017	0.000023		0.000008	0.000021		0.64637	0.9579		0.353577	0.939043	
Cot_price	-0.001386	0.001804		-0.001361	0.001806		-0.0014	0.0018		-0.001357	0.001833	
MZ_price	0.000608	0.000946		0.000323	0.000931		0.00069	0.00094		0.000373	0.000895	

Source: Author’s calculations from PHS data

Table 4.8: Unconditional APEs, Fixed Effects Cragg model

	FRA_mt						FRA_ratio					
	FISP_mt			FISP_ratio			FISP_mt			FISP_ratio		
Variable	APE	SE	sig	APE	SE	sig	APE	SE	sig	APE	SE	sig
tot_hect	0.141276	0.006830	***	0.141077	0.006957	***	0.1413	0.00679	***	0.141103	0.006430	***
animal_trac	0.126914	0.050122	**	0.124579	0.049912	**	0.12785	0.05013	**	0.125257	0.043591	***
mech_trac	-0.162985	0.191412		-0.165952	0.184836		-0.1679	0.18918		-0.170454	0.203793	
ag_hd	-0.003486	0.000547	***	-0.003457	0.000547	***	-0.0035	0.00055	***	-0.003458	0.000632	***
educ_hd	-0.001089	0.001342		-0.001111	0.001339		-0.0011	0.00135		-0.001126	0.001261	
fem_hd	-0.196085	0.033179	***	-0.196687	0.033088	***	-0.1958	0.03316	***	-0.196502	0.035270	***
dep_ratio	-0.020344	0.008865	*	-0.020548	0.009064	*	-0.0204	9.08E-03	*	-0.020554	0.009817	*
hh_labor	0.003883	0.005593		0.003942	0.005550		0.00385	0.00565		0.003913	0.005559	
yr_0506	-0.410341	0.585580		-0.479974	0.595300		-0.3981	0.59356		-0.466680	0.518770	
FISP	0.000026	0.000020		0.223855	0.282140		2.5E-05	2E-05		0.227660	0.287692	
FRA	0.000025	0.000014		0.000020	0.000014		0.96261	0.56647		0.820071	0.574474	
Cot_price	0.000442	0.001029		0.000616	0.001035		0.00041	0.00104		0.000584	0.001138	
MZ_price	0.000454	0.000528		0.000205	0.000512		0.00051	0.00054		0.000254	0.000420	

Source: Author's calculations from PHS data

4.6 Exploring the validity of the policy variables

Based on the results of the FISP and FRA variables, we determined that additional tests should be conducted to establish with more confidence their ability to capture their intended effects. In Model 1, most of the APEs for our FRA variables show positive effects and several are significant. Model 2 shows our FRA and FISP variables to have no significant APEs at any stage in any model. The inconsistency in effects across models for the FRA and FISP variables raise some questions about their ability to capture the real situations and expectations of smallholder households.

To test these variables and their effectiveness, we run the same CRE Cragg model, but we use the decision to plant maize and maize areas planted as our dependent variables in place of cotton. Our reasoning is simple: we anticipate a stronger, more direct, and more uni-directional relationship between the maize supports and maize planting than between maize supports and cotton planting. We ran Cragg models using two different FISP variables (metric tons and percent of households receiving), two different FRA variables (metric tons of maize purchased and metric tons per capita), in the same way that we did for the cotton regressions. However, unlike the Cragg models run on cotton, we use all households available in the panel (3,775 households in each year); we do not limit the observations to SEAs with at least one household that planted cotton. When we limit the estimations to the same SEAs used in the cotton regressions there are only 14 observations (0.5% of the total observations) that did not plant any maize. There are too few observations that did not plant maize to accurately test the decision (first) stage of the estimation. When we include all SEAs, there are 842 observations (11% of the total observations) that did not plant maize – enough to accurately estimate all stages of the models.

The APEs, standard errors and significance levels for our FRA and FISP policy variables resulting from the maize regressions are displayed in Table 4.9. All of the estimated APEs are positive, though only FRA variables show any significance. The unconditional APEs of our FRA variables are significant in three of our four model estimations. When our FRA variable is defined as the metric tons of maize purchased divided by the number of households at the district level, the APEs for the second stage are significant as well.

There were no significant policy variables in the first stage of any of the models. This result is likely caused by the fact that a very high percentage of households in every province already grow maize (see Table 3.6) making it difficult for any variable to have a significant impact on the planting decision.

To clarify, in our additional regressions executed with maize planting dummies and maize areas planted as the dependent variables for the first and second stages respectively, we find no significance for our FISP variables, but we find significant and meaningful APEs for our FRA variables. These results are logical and consistent with our expected effects of FRA and FISP. These estimations present a believable representation of our maize support variables and provide credence to their ability to capture the true effects of FRA and FISP maize supports on cotton planting decisions.

Table 4.9: Maize CRE Cragg model results of FRA and FISP variables

	FRA_mt						FRA_ratio					
	FISP_ratio			FISP_mt			FISP_ratio			FISP_mt		
	Coeff	SE	sig	Coeff	SE	sig	Coeff	SE	sig	Coeff	SE	sig
1st stage conditional APEs												
FRA	1.97E-06	2.19E-06		1.54E-06	2.09E-06		0.050019	0.034569		0.0431821	0.0333471	
FISP	0.087635	0.088066		0.0000104	0.0000263		0.098591	0.094234		9.59E-06	0.0000284	
2nd stage conditional APEs												
FRA	2.41E-06	1.77E-06		1.76E-06	1.98E-06		0.067888	0.04537	*	0.0706591	0.0445235	*
FISP	0.292191	0.377778		0.0000119	0.00002		0.201998	0.363625		0.0000202	0.0000176	
Unconditional APEs												
FRA	3.22E-06	1.85E-06	*	2.41E-06	1.98E-06		0.087464	0.042857	**	0.0858721	0.0418037	**
FISP	0.304239	0.329032		0.0000163	0.0000233		0.231775	0.317384		0.000023	0.0000222	

Source: Author's calculations from supplemental survey data (SS08 and SS04)

5. CONCLUSIONS, POLICY IMPLICATIONS AND FURTHER RESEARCH

5.1 Conclusions

Cotton production in Zambia has been an outstanding example of private sector led agricultural growth since liberalization in 1994. The concentrated sector structure has helped facilitate an outgrower scheme that has supplied farmers with quality inputs and extension services resulting in a greater than 1,000% increase in seed cotton production from harvest years 1994 to 2005 (Figure 1.2). Cotton is primarily grown by smallholder farmers. Cotton production can be more profitable than alternative crop choices and seed cotton sales can provide much needed cash for cash-strapped households. Another benefit of cotton cultivation during the period of this study is that the outgrower scheme provided a direct path to the guaranteed sale of all cotton output at a price typically announced prior to planting[7]. As many smallholders have limited market access, the value of having a guaranteed buyer and a price set for a household's output even before planting should not be overlooked.

Despite these substantial production increases and benefits to growers, the cotton sector has been unstable. A number of challenges to the sector have adversely affected production and engendered two collapses during the 2000 and 2007 harvest years. One internal challenge to Zambia's cotton sector has been side-selling of harvested cotton, which is periodically brought on by newer, smaller cotton ginneries entering the market and undercutting farmers' existing agreements with other ginners. These newer entrants face low barriers to entry in the largely unregulated cotton sector and they can offer farmers a higher price for their seed cotton than can the companies that have supplied the inputs to the households, because they do not need to recover the loan value. Farmers selling to these new entrants are unlikely to repay their loans to

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[7] Dunavant, however, stopped announcing preplanting prices after the 2006/07 growing season.

the established companies, which may respond by contracting with fewer farmers the following season. While Zambia's unregulated cotton sector is particularly vulnerable to side-selling, the parastatal monopolies in WCA have done well to limit side-selling through a heavily managed scheme.

Other challenges can come from outside the sector, including rapid interest rate fluctuations or currency overvaluations. These external challenges contributed to the cotton sector's second collapse in 2007 as an appreciation of the kwacha relative to the US dollar harmed Zambia's export sectors and cotton ginners were unable to pay farmers their announced pre-planting minimum prices. Repayment rates fell, and the following season, 2006/07, saw the most dramatic drop in production volumes to date.

Another possible external challenge to the cotton sector is the government's heavy promotion of maize production. Since the 2005 harvest season, the Zambian government has dramatically increased their supports to smallholder maize production through two major institutions, the FRA and the FISP. These supports have combined to make maize production relatively more profitable. These programs have several known problems with their execution, and may additionally pose a challenge to Zambia's cotton sector.

Using two estimation methods, we find no evidence that government maize supports through FRA and FISP have negatively impacted smallholders' cotton planting decisions. In fact, Model 1 results show some significant and positive (though small) impacts of FRA maize purchases and cotton planting decisions. This suggests that the potential positive effect of cotton farmers taking advantage of residual fertilizer used on maize fields by planting cotton the following season (discussed in section 4.2) was large enough to outweigh any negative effect of farmers substituting maize for cotton in their fields. Model 2 results, which show no significant effects of maize supports on the cotton planting decisions, suggest that these countervailing effects were offsetting. We find three potential sources of dissimilarity in our results.

The first potential source of variation is that our models control for time-constant unobserved effects at different levels; Model 1 controls for these effects at the household level while Model 2 controls for them at the wider, SEA level. A second potential source of discrepancy is that the models were created with different data sets and while we remained as consistent as possible in our variable definitions, the same set of variables was not available for both models. The third potentially problematic difference between our two methods is that we were unable to use the same years for both estimation procedures – Model 1 uses data from the 2003 and 2007 harvest years while Model 2 uses data from 2003 and 2006.

While the results of our two models differ slightly, the results are consistent in showing no negative effects of maize supports (FRA maize purchases and FISP subsidies) on cotton planting decisions by smallholders through the 2006/07 growing season.

5.2 Policy Implications

Our results indicate that the FRA and FISP maize supports that were introduced (or re-introduced) and expanded considerably over the time period covered by our two models (2002/03 and 2005/06 growing seasons in Model 2 and 2002/03 and 2006/07 in Model 1) did not negatively impact the cotton sector over the time period we analyzed. These results imply that problems facing the cotton sector through the second crash in the 2006/07 growing season were were due primarily to internal issues within the sector's structure. This turns the policy focus away from the maize sector supports towards the lack of support for the cotton sector.

Both of Zambia's cotton production crashes were the result of poor credit repayment. Newer, smaller firms easily entering the cotton sector due to its low barriers of entry caused side-selling of cotton and low credit repayment rates during both crashes. Tschirley, Poulton, and Labaste (2009) suggest that concentrated cotton sectors like Zambia's should help control these inherent problems by creating a "flexible and commercially supported regulatory regime." By suggesting that the serious problems in the sector at the end of our period of analysis were not the result of FRA and FISP maize supports, our research turns attention back to internal sectoral issues highlighted by other analysts.

Yet FRA and FISP supports have continued to increase dramatically since the end of this analysis: FISP distributions during the 2009/10 growing season were more than three times their levels of 2006/07, while FRA purchases in 2010 were more than double those in 2007. Might these dramatic increases in maize supports contributed to the stagnation of the cotton sector since the 2006/07 crash? Further research needs to be done to determine the impacts of these much higher support levels. The fact remains that the FRA and FISP supports to smallholder maize production are expensive: the FISP alone accounted for about 35-40% of Zambia's agricultural budget annually (Xu et al, 2009) prior to the 2009/10 growing season where the FISP planned a greater than 33% increase in fertilizer volumes distributed and a greater than 166% increase in the number of intended recipients (Table 3.1). While some smallholder households may be producing more maize than they otherwise would as a result of the policies, there may be some hidden, harmful effects on the production of other crops – particularly cash crops like cotton. MACO and the Zambian government need to have an understanding of the full costs of their agricultural policies. If, in fact, the maize supports have begun to have negative effects on the once promising and thriving cotton sector and are impeding the sector's recovery following the second production crash, this information needs to be made available to policy makers.

5.3 Further Research

There are two ways to expand this research and potentially strengthen our results. Both improvements involve expanding our models to include data from additional years. At least one additional year's data could be included in each of our models using existing data. SS01 data could be added to Model 1 by adapting and loosening our "dependency ratio" and "productive asset value" variable definitions. In our dependency ratio variable, the lower age limit for a working age adult would have to be adjusted to twelve years old to conform with the more limited information gathered in SS01 on household members' ages: the value of productive assets variable would need to be based, during all three years of the panel, on the more restricted set of assets collected in SS01. In Model 2, PHS data from 2004/05 could be included by changing the definition of our expected maize price variable. The 2003/04 PHS did not collect data on prices paid to farmers, so we could not create the naïve price in the same way that we did for the other years. One possible solution would be to utilize the AMIC monthly maize price data to create a variable that closely follows the prices paid to farmers.

While adding another year to each estimation procedure would provide the benefit of more robust results, it would be at the cost of specifying our models differently. Also, the fact remains that these expanded models would not capture any effects beyond the 2006/07 growing season and would not help in explaining the more recent effects of the maize support programs.

The relationship between FRA maize purchases, FISP fertilizer distributions and smallholders' cotton planting decisions has unfolded further since the 2006/07 growing season and it is continuing to unfold. Aggregate cotton production volumes have shown an anemic recovery following the crash in 2007 and the FRA and FISP maize supports have increased their activities – and likely their influences on smallholder cropping decisions – since that season. Particularly, the FISP has increased its fertilizer distribution substantially (Table 3.1). While this research shows no indication that the cotton sector was negatively impacted by the maize support programs, it is possible that this relationship has changed since the 2006/07 growing season.

For these reasons, the best and most relevant way to improve this study would be to include data from a more recent growing season. While such data are not available yet, we expect another round of the supplemental survey to be conducted during 2012. If this survey can collect retrospective information on cotton production covering the 2009/10 and 2010/11 seasons, this data could be added to Model 1 and the resulting two stage estimations would help uncover the more recent relationship between Zambia's growing maize supports and its lagging, still largely unregulated cotton sector.

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