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Interlinked Transactions in Cash Cropping Economies: Rationale for Persistence, and the Determinants of Farmer Participation and Performance in the Zambezi Valley of Mozambique

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NOTE

This document is a reprint of Chapter 3 of Rui M.S. Benfica's (2006) Ph.D. dissertation in the Department of Agricultural Economics at Michigan State University. It includes an Executive Summary, and was reformatted to be published as a stand alone piece. The primary data utilized for this study—the Rural Household Survey in Cotton and Tobacco Concession Areas in the Zambezi Valley of Mozambique—was collected in two rounds with 300 farming households (HH) in the 2003/4 agricultural season.

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Interlinked Transactions in Cash Cropping Economies: Rationale for Persistence, and the Determinants of Farmer Participation and Performance in the Zambezi Valley of Mozambique

Rui M.S. Benfica

EXECUTIVE SUMMARY

Livelihood strategies among rural HHs in the Zambezi Valley are predominantly based on agricultural activities, but income diversification is increasingly important. Cash income from agriculture comes predominantly from tobacco and cotton production. Due to cash constraints and poor access to input and credit by farmers, and high demand from buyers to meet quality and volume requirements, contract farming (CF) is the dominant form in the organization of transactions in those cash cropping sectors.

The objectives of this study are twofold. First, we sought to understand the nature of CF schemes for cotton and tobacco, and the rationale for their persistence. Then, we developed econometric models to assess the determinants of farmer participation and profitability in CF. Those models are extended to assess the effects of participation on agricultural and total HH incomes, accounting for threshold effects of education and land holdings to identify more precisely the types of farmers likely to benefit more from CF.

The data for this study comes from a two-round survey undertaken with 300 HHs in tobacco and cotton concession areas of the Zambezi Valley of Mozambique. It covered both cash crop growers and non-growers. The HH level survey collected data on HH characteristics, the level of intermediate input use and the variation in factor use, particularly seasonality in labor demand and HH decisions with respect to the use of family or wage labor and its allocation across competing activities. The survey also collected data on production and marketing of crops, livestock, fishing, non-farm enterprises and wage labor, asset ownership, and remittance income.

The institutional/transaction costs analysis indicates that in both sectors CF arrangements appear as an institutional response to widespread failure in input, credit and output markets, and the lack of an effective public and private service provision network. The outgrower firms (ginners in cotton and multinational trading/exporting firms with processing facilities in neighboring countries in the tobacco sector) need to ensure product quality and a large volume of purchases to reduce unit marketing and processing costs. In general, farmers have very few cash generating alternatives, so that input credit and a guaranteed output market appear as an important opportunity. Looking at specific factors related to production, marketing and processing characteristics of the crops, and a set of economic and political factors, the analysis concludes that some level of non-market vertical coordination is likely to emerge under these circumstances as pure spot markets are absent on both the input and the output sides and production specifications require some degree of supervision and specific production techniques. This is particularly important in tobacco, which uses a wider range of productivity enhancing input and is more demanding in its field practice requirements. The analysis finds that full vertical integration, i.e., plantation type arrangements, is not feasible due to the labor intensive nature of the production process that would make labor supervision costs extremely high. Also, under a plantation type arrangement, the firms would be obliged to pay the statutory agricultural minimum wage which is generally higher than the informal wage that smallholders pay to hired labor and, in some cases, even higher than the implicit wage that most smallholders end-up earning as contract cash crop growers.

While CF allows these systems to function, asymmetric information and unbalanced bargaining power over issues such as prices and grading have emerged as barriers to its development. Furthermore, especially in cotton, low world market prices, low ginning outturns, and low productivity at the farm level have constituted major constraints. These are,

in part, consequences of a wide range of market and coordination failures and weaknesses in the concession system, many of which are beyond the scope of this study. This paper focuses on understanding the direct effects of the systems as they currently exist.

For each sub-sector we used a standard sample selection model to assess the determinants of farmer participation and, to analyze the factors explaining the level of profits accruing to scheme participants. Then we used a treatment effects model to assess whether farmer participation in CF schemes has a significant impact on levels of crop and total HH. To identify the types of farmers that benefit from participation, we investigated the effects of participation interacted with thresholds of educational attainment and land holdings.

Probit results for *tobacco areas* indicate that HH participation in tobacco CF schemes is more associated with endowments, technology, and income diversification opportunities and less with demographic characteristics. First, there are no effects of HH head gender, nor effects of educational attainment. Second, the availability of draft animals, and the value of production tools increases the likelihood of farmer participation. Third, there are no land threshold effects on participation. Finally, HHs with greater livestock sales and wage labor are less likely to participate in CF schemes.

Tobacco growing HHs exhibit highly variable profits; 30% lost money during our survey year, while average annual profits were $730.74, which represents nearly half the value of their total crop production. The analysis of the determinants of tobacco cash income in the second step does not give evidence of sample selection bias. Once HHs choose to engage in tobacco production, some effects are observed. First, the level of education attained by the head of the HH is not statistically significant. However, education plays an important role in determining access and outcomes in off-farm income in tobacco growing areas. Regression analysis using a two-stage procedure indicates that education of the HH head is an important determinant of participation in both self-employment and wage labor in tobacco growing areas. However, only wage labor market earnings are statistically increased with the educational attainment of the head. Second, female headed HHs run less profitable tobacco farming operations, with profits that are, on average, $400 lower than those of their male counterparts. Third, land holdings have a large effect on profits only at the highest threshold level, with profits of land rich tobacco growing HHs averaging $780 over that of land poor tobacco growers; effects at lower levels of land holdings are not statistically significant. Fourth, the value of HH production assets has a positive and statistically significant effect on earnings. Finally, agro-ecological/location specific fixed-effects are observed; grower HHs in mid-high altitude areas have profits significantly higher than those of their counterparts in drier, lower altitude areas.

Model results for *cotton areas* in the first stage probit indicate that the likelihood of participation is not positively associated with the educational attainment of the HH head. This is consistent across cotton areas in Mozambique, where more educated HHs show a higher propensity to engage in more profitable non-farm activities. Two-stage regression analysis in cotton areas in the study region, however, show that there is a positive association between education and participation in non-farm self employment, but it is not statistically significant. Likewise, a non-statistically significant relationship is found between education and outcomes in non-farm activities. Some other results stand out. First, HHs that have larger areas of land are more likely to engage in a contract; all land threshold dummies are statistically significant. This is in sharp contrast with the tobacco results, which showed no impact of land holdings on participation. A possible explanation for this difference is that while land is the single most important factor for cotton production (under the current technological package), participation in tobacco is more demanding, including the (unobserved) ability required to manage production resources in a more complex set of field activities. Second, unlike in tobacco areas, a higher value of production and marketing assets has no effect on the likelihood of participation in the schemes. Third, access to alternative sources of income, such as livestock and self-employment, reduces the demand for cotton production contracts. Due to the overwhelming use of family labor, wage labor income opportunities do not compete with direct participation in CF.

Cotton growing HHs also exhibit variable profits, with 20% incurring losses; average profits are only $93.60 per year, less than 20% of the value of their total crop production. Second stage ordinary least squares (OLS) regression results for farmer performance in cotton schemes indicate the presence of sample selection bias. Among demographic variables, only the number of adult equivalents is statistically significant at 10%, each adding on average $37 per year. Education of the HH head is the only other demographic variable close to significant, which is a rough indication that, although highly educated heads tend not to participate in cotton farming, when they do, they may do better than the less educated ones. Furthermore, like in tobacco areas, total area owned is statistically significant only at the highest land holding quartile, where land rich cotton smallholders exhibit profits that are close to $150 higher than those of land poor cotton growers. Also, the value of production and marketing equipment increases returns to cotton. Finally, profits in all DUNAVANT-Mozambique locations are statistically lower than those in Gorongosa , a C.N.A. area.

The *Treatment Effects Model* is designed to analyze the effect of participation associated with education attainment and land holding thresholds, on the levels of crop and total HH income, controlling for other factors.

The model performs well in both areas and reveals some important results. In *tobacco areas* there are indications of significant returns to participation, but only at the highest land holdings threshold for both crop and total HH income levels; interaction effects of participation and land area owned dummies are only statistically significant and sizable ($1,306) at the highest land quartile. The magnitude and significance at that level is stronger for total HH income ($1,576) suggesting that even larger farmers appear to not be giving up on profitable off-farm income generating opportunities. There are no participation-education threshold effects. This is a surprising result for a crop that requires careful management and which features steep price discounts for poor quality; further investigation is warranted. The model reveals that female headed HHs in tobacco areas earn lower crop income than their male counterparts ($488 less). However, differences in total income are not statistically different, which may suggest that off-farm income contributes to reduce gender differentiation in income in those areas. Higher value of production and marketing assets contributes to higher total HH income. Finally, the model exhibits weak agro-ecological or location fixed effects. Likewise, income of participants across locations are relatively balanced.

The treatment effects model results for *cotton areas* show no statistically significant returns to participation, even when land holdings and education thresholds are interacted with participation. This indicates that total crop and total HH incomes between cotton growers and non-growers, after controlling for demographic, factor and asset/technology endowments, and spatial factors, are not very different, and even income across participants differentiated by land or education attainment are not very different.

Like in tobacco growing areas, but with an effect smaller in magnitude, higher value of production and marketing assets contributes to increased crop and total HH income in cotton areas. There are no significant district fixed-effects in cotton areas.

In general, the cotton and tobacco sectors in Mozambique have provided a great deal of the rural population in concession areas with a secure source of cash income in areas where alternative income generating activities are limited. These cash crop sectors are currently faced with a number of pressing issues.

One such issue is the low profitability of cotton (associated with low prices and low productivity) relative to tobacco in the Zambezi Valley region. Part of the reason for this poor performance relates to the nature of the cotton concession model as applied in Mozambique—which precludes competition and does not balance this with any effective performance monitoring system. Therefore, we suggested that high priority be given to the development of a more adequate management of the concession system in the near future. Increased profits in cotton can be achieved with increased farm size and a higher level of production assets. However, there are no landholding threshold effects on total crop income nor on total HH income, which suggest that the cotton activity generates some, but not yet very strong, economic linkages that can sustain overall economic gains. This calls for policies aimed at higher yields at the farm level and the promotion of non-farm businesses in those economies.

Given its expansion path, for long term sustainability in tobacco, adverse environmental impacts deserve more attention.

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LIST OF ACRONYMS

ARB	Arachide de Bouche Peanut Program
CDF	Cumulative distribution function
CEPAGRI	Centre for the Promotion of Commercial Agriculture
CF	Contract farming
C.N.A.	Companhia Nacional Algodoeira
DAP	Departamento de Análise de Políticas
DINA	Direcção Nacional de Agricultura
ha	hectare
HH	Household
IAM	Instituto do Algodão de Moçambique
IMR	Inverse mills ratio
JFS	João Ferreira dos Santos
LS	Level of significance
MA	Ministério da Agricultura/Ministry of Agriculture
MLE	Maximum liklihood estimation
MLT	Mozambique Leaf Tobacco
MSE	Micro-small enterprise
OLS	Ordinary least squares
S.E.	Standard errors
TIA	Trabalho de Inquérito Agrícola/National Agricultural Survey
$US	United States dollar

1. INTRODUCTION

CF is the most pervasive form of market organization in cash crop production in Mozambique. All cotton and tobacco production by smallholder growers in the Zambezi Valley region originates from CF arrangements promoted by agro-industrial firms. In total, there are two outgrower tobacco companies and three firms devoted to the management of cotton CF schemes. Those firms are assigned specific geographical "concession" areas, where they provide input and extension assistance to small farmers on credit, and are granted monopsony rights that entitle them to purchase all the output at predetermined prices.

Contract coordination, through CF interlinked transactions, present several potential advantages. First, it helps to cope with market failure by reducing uncertainty for farmers regarding access to input, services, and output markets (Glover 1984; Goldsmith 1985; Minot 1986) and by assuring access to sufficient raw material of acceptable quality for processors. Second, it may significantly raise income of growers and enhance rural development by serving as a source of information for new production technologies. Finally, it may trigger multiplier effects through employment linkages, and infrastructure and marketing development in the local economy (Warning and Key 2002).

There are also potential limitations and negative impacts of CF. First, given its monopsonic nature, these arrangements may result in asymmetric bargaining where one buyer largely determines the prevailing price and contract conditions. After farmers have invested in specific assets, or altered their cropping patterns and become more dependent on their contract crops, they may lose bargaining power and be more likely to accept less favorable or exploitative contract terms (Little and Watts 1994). Second, the cost of enforcing contract provisions can be very high for both parties due to opportunistic behavior by participants and weaknesses in the legal system in rural areas. Finally, CF may result in barriers to entry for farmers when processors limit suppliers to those capable of meeting volume and quality standard requirements, typically the already better off farmers (Benfica, Tschirley, and Sambo 2002).[1]

In addition to the quality and intensity of the assistance, the prevailing prices, and overall world market conditions, the performance of CF schemes and their broader impact on rural development depends on the types of growers that get contracted. It is clear that if firms contract primarily with wealthier growers, the poorer members of the community will fail to benefit directly from the contract arrangements (Warning and Key 2002). Nevertheless, the extent to which such approaches will exacerbate existing patterns of economic stratification, as argued by Key and Runsten (1999), cannot be conclusive without further investigation. The net effect depends upon the extent of economic linkages. In the Zambezi Valley case, at least three effects are especially important: (i) spillover effects on food crop yields through increased fertilizer use and input market development; (ii) the effects of increased labor demand and re-spending of wage earnings; and (iii) multiplier effects from re-spending of cash crop earnings. The presence of these important spillovers from growers to non-growers makes the assessment an empirical question.

[1] In addition to those limitations, widespread contractual coordination may raise price volatility in the remaining spot market transactions, due to the thinness of those markets and the lack of transparency across many contracts within the same sub-sector. This will reduce or distort the information supplied by those spot market prices.

The objective of this paper is as follows. First, we developed a conceptual framework following Williamson (1991) and link it to an institutional analysis to identify the factors determining the dominance of CF in cotton and tobacco value chains in the Zambezi Valley region. Second, taking into account the selective nature of participation in those schemes and the stratified random nature of our sample, we developed two versions of sample selection models (Heckman 1979; Greene 2003) to address the following issues: (i) the determinants of farmer selection into the CF schemes; (ii) once selected into the schemes, the determinants of participants' performance; and (iii) assess whether overall agricultural and total HH income of participants is statistically higher than that of non-participants after controlling for demographic, factor and asset endowments, structural factors, and sample selection bias. A key contribution of this paper is its investigation of threshold effects of education and land holdings. Rather than focusing on the average effect of participation, we asked *what type* of farmer benefits from participation; an answer to this question is crucial for policy design and to shed light on the identification of effective expansion paths to companies.

While sample selection and treatment effect models are common in many areas, applications to the performance and impact of CF in developing countries are rare. Warning and Key (2002) used a treatment effect model to analyze the impact of the *Arachide de Bouche* confectionary peanut program (ARB) in Senegal. They found that program participants and non-participants were indistinguishable by wealth measures and that participating farmers increased their gross agricultural income substantially. One limitation of their study was the extremely small sample size, only 26 observations. Our study is an empirical contribution to the literature in three ways. First, it uses a much larger sample size and controls for a larger set of variables than previous studies. Second, we used interaction terms to assess how participation effects vary across thresholds of land holdings and education. Finally, we extended the analysis to include a standard sample selection model and evaluate the determinants of farmer selection and performance within the CF scheme itself.

This paper is organized as follows. Section 2 gives an overview of the tobacco and cotton sub-sectors in Mozambique, including some measures of its recent performance, and puts the study region into perspective. Section 3 develops a conceptual framework for the analysis of the organization of production and trade in the value chains, and identifies the nature of CF and the factors leading to its dominance in the Zambezi Valley region. Section 4 reviews the study area sampling coverage and undertakes a comparison of means between scheme participants and non-participants for selected HH level variables. Then it outlines the sample selection problem and correction, and the specification of the cash crop income determinant model and the treatment effect model with sample selection correction and land holdings and education threshold effects. Finally, it presents the estimation and the discussion of results for both models. Section 5 closes with the discussion of policy implications.

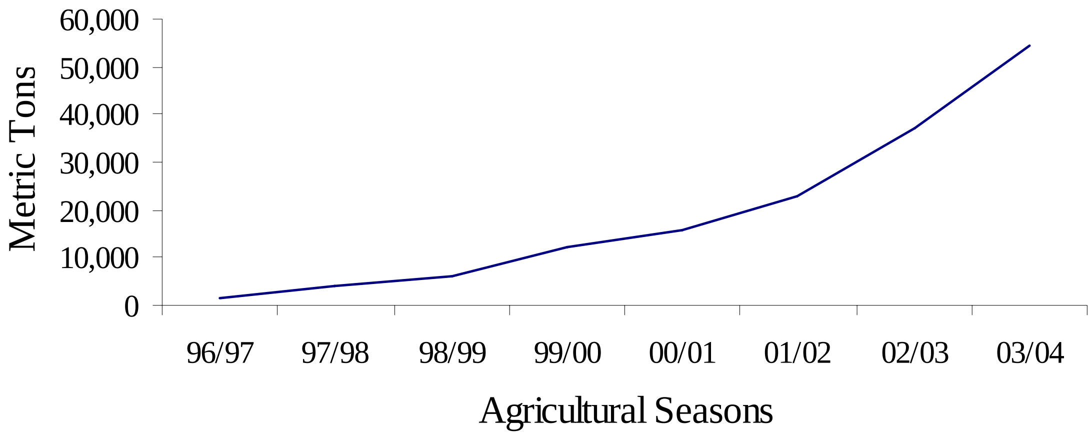
2. AN OVERVIEW OF THE COTTON AND TOBACCO SUB-SECTORS

This section presents an overview of the tobacco and cotton sectors in Mozambique. It starts by looking at national production trends over the past decade. Then it characterizes the 2003/4 agricultural season by province and by firm, and puts the study region into perspective.

2.1. The Tobacco Sector

Tobacco production in Mozambique has grown very rapidly over the past decade. From 1,500 tons in the 1996/7 agricultural season, national production of raw tobacco has increased every year to reach over 54,000 tons in 2003/4 (see Figure 1). Over the same period, the estimated number of tobacco growing HHs has increased from 6,000 to more than 100,000.

Figure 1. Raw Tobacco Production in Mozambique 1996/7-2003/4



Source: DINA-MA

There are currently five major firms/partnerships operating in the country promoting both smallholder CF schemes and larger scale commercial operations.[2] The positive impact of this rapid expansion in the tobacco sector on rural smallholder HH income and welfare has been dramatic (Walker et al. 2004; Donovan 2004; Boughton, Mather, and Tschirley 2004; Benfica et al. 2004; Benfica et al. 2005). Table 1 presents key tobacco sector statistics for the agricultural season 2003/4.

[2] The firms/partnerships operating in the country are: MLT (Tete and Manica); JFS (Manica, Nampula, Cabo Delgado, Niassa, and Gaza); DIMON-Mozambique (Tete, Manica, and Sofala); Stancom/Mosagrius (Niassa); and Stancom/Sonil (Nampula).

Table 1. Key Statistics of the Tobacco Sector in Mozambique, 2003/4

Province/firms	Area Planted		Production		Yield (tons/ha)
	Area (ha)	%	Volume (tons)	%	
All Mozambique	62,315	100.0	54,408	100.0	0.87
Total by Province					
Niassa	8,977	14.4	7,692	14.1	0.86
Cabo Delgado	82	0.1	82	0.2	1.00
Nampula	5,985	9.6	3,625	6.7	0.61
Zambézia	3,991	6.4	2,391	4.4	0.60
Tete	32,381	52.0	27,032	49.7	0.84
MLT	23,849	38.3	20,000	36.8	0.84
DIMON	8,532	13.7	7,032	12.9	0.82
Manica	10,359	16.6	13,214	24.3	1.28
Sofala	510	0.8	360	0.7	0.71
Gaza	30	0.0	12	0.0	0.40
Total by Firm					
JFS	13,127	21.1	9,341	17.2	0.71
MLT	25,288	40.6	22,920	42.1	0.91
DIMON	12,594	20.2	10,950	20.1	0.87
STANCOM	11,306	18.1	11,197	20.6	0.99

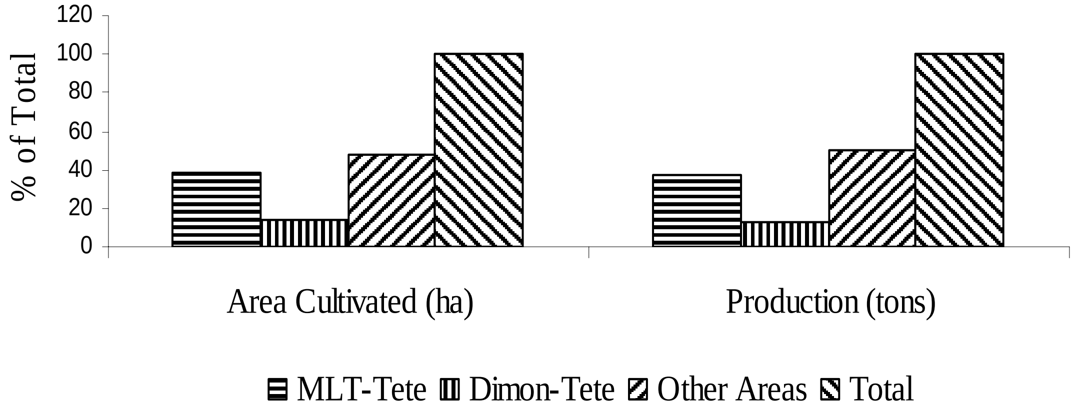
Source: DINA-MA, and individual firms
Notes: The total number of growers in the country is estimated at over 100,000. From those, 44,783 work in Tete Province alone (MLT: 34,038 and DIMON-Mozambique: 10,745). Due to the absence of precise data for most of the firms, data on the number of producers is not detailed in the table.

Overall, there were 62,315 ha of land planted with tobacco in eight provinces. That area includes commercial farming by large growers and smallholder growers involved in CF schemes. Total production in that season reached over 54,000 tons of raw tobacco, of which about three-quarters are of the burley type. The total number of growers is estimated at over 100,000.

About 52% of the total area planted nationally and 50% of the total production was by smallholder growers in our study region (Tete Province). Those farmers were engaged in CF schemes with MLT (37% of the national production by 34,038 farmers), and DIMON-Mozambique (13% of the national production by 10,745 farmers).[3] See the percentage distributions of land area and production in Figure 2.

[3] Note that if we account for the production those two firms get from their global operations in the country, their national production share is much higher: MLT 42% and DIMON-Mozambique 20%.

Figure 2. MLT-Tete and DIMON-Mozambique-Tete in Total Area and Production 2003/4 Season

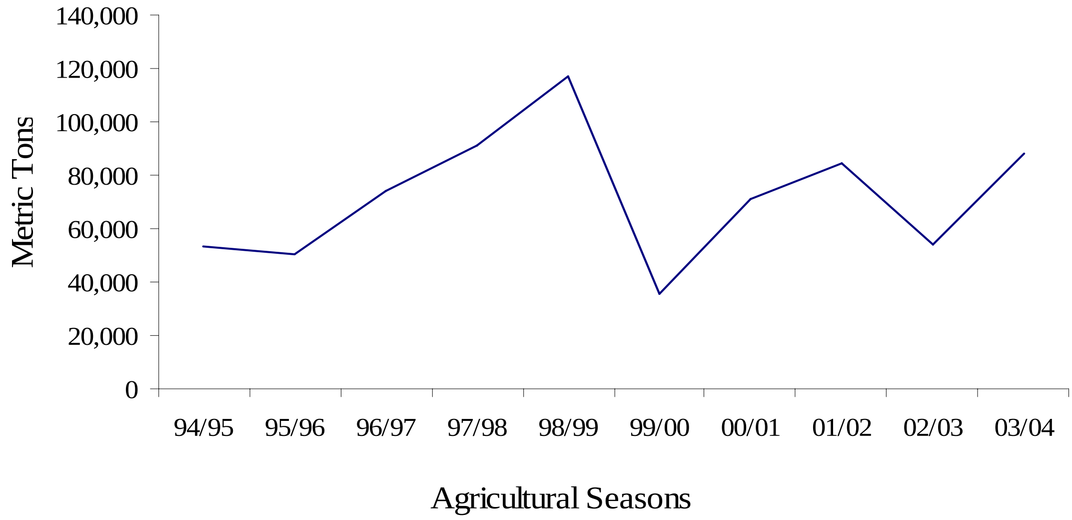


Source: DINA-MA and tobacco companies

2.2. The Cotton Sector

Cotton production in Mozambique has varied widely over the years. Current production is dramatically higher than from the early to mid-1980s, but is only about 60% of the historical high, achieved more than 30 years ago. Key factors explaining the decline are persistently low producer prices, the lowest in the region, and issues related to the organization and performance of the CF arrangements between ginning/exporting firms and smallholder farmers. The production of 88,000 tons achieved in 2003/4 still falls short of the ten-year high achieved in 1998/9 (Figure 3).

Figure 3. Seed Cotton Production in Mozambique 1994/5-2003/4



Source: IAM

Historically, cotton production in Mozambique has been concentrated in the northern part of the country, particularly in Nampula Province, but that pattern is currently changing.

Between 1990 and 2000, Nampula production accounted, on average, for 52% of national production, against only 12% for all central provinces (Tete, Zambézia, Sofala, and Manica). By 2003/4 the figures were 39% and 29%, respectively. This shifting balance has been driven by continuing problems in Nampula, and by the entrance of two new firms in the center committed to increasing yields and overall development of the supply chain (Tschirley, Ofiço, and Boughton 2005).

Table 2. Key Statistics of the Cotton Sector in Mozambique, 2003/4

Province/firms	Growers	Area Planted		Production		Yield
	Growers	Area (ha)	%	Volume (tons)	%	(tons/ha)
All Mozambique	107,845	174,157	100.0	88,173	100.0	0.51
Provinces						
Niassa	-	14,863	8.53	7,817	8.87	0.53
Cabo Delgado	41,671	38,958	22.37	20,819	23.61	0.53
Nampula	24,759	75,606	43.41	34,144	38.72	0.45
Zambézia	9,918	13,957	8.01	3,940	4.47	0.28
Tete	7,430	7,361	4.23	4,256	4.83	0.58
DUNAVANT	4,022	2,257	1.30	1,037	1.18	0.46
AGRIMO	3,408	2,627	1.51	1,839	2.09	0.70
COTTCO	-	2,477	1.42	1,380	1.57	0.56
Manica	1,685	7,531	4.29	4,067	4.61	0.54
Sofala (C.N.A.)	22,382	15,937	9.15	13,130	14.89	0.82
Total by Firm						
SAN/JFS	-	18,923	10.87	11,208	12.71	0.59
PLEXUS	32,691	31,312	17.98	17,485	19.83	0.56
SODAN	32,987	25,430	14.60	10,544	11.96	0.41
MOCOTEX	215	2,739	1.57	427	0.48	0.16
SANAM	-	31,047	17.83	11,137	12.63	0.36
CANAM	-	20,460	11.75	10,774	12.22	0.53
IAM/MEMBA	470	400	0.23	48	0.05	0.12
AGRIMO	13,326	8,434	4.84	4,770	5.41	0.57
SAAM	-	5,500	3.16	607	0.69	0.11
DUNAVANT	4,022	2,257	1.30	1,037	1.18	0.46
COTTCO	-	8,758	5.03	4,562	5.17	0.52
C.N.A.	24,067	17,131	9.84	14,015	15.89	0.82
Autonomous	67	1,766	1.01	1,559	1.77	0.88

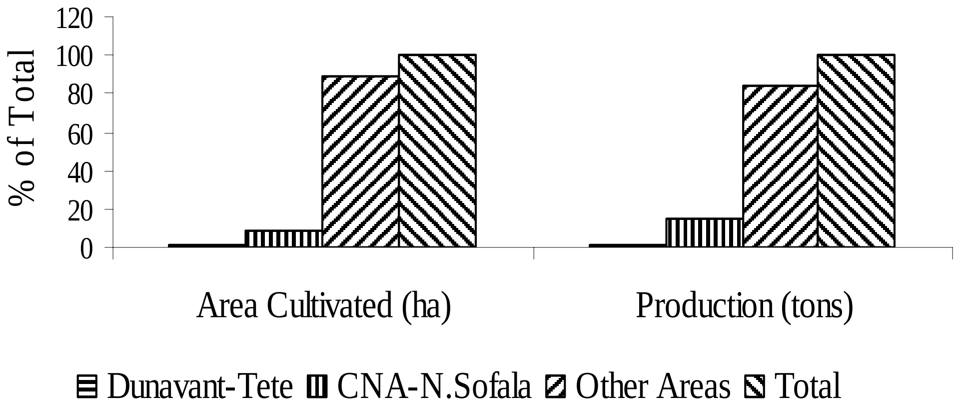
Source: IAM and individual firms
Note: DUNAVANT and AGRIMO merged recently

In terms of individual firms, in 2003/4 (Table 2), Plexus (in Cabo Delgado Province, north of Nampula) accounts for 18% of the area cultivated and 20% of total production. C.N.A. in the center is second with about 16% of national production, in spite of cultivating only 10% of national cotton area.[4]

[4] Yields by C.N.A. farmers (0.82 tons/ha) are well above the national average of 0.51 tons/ha in 2003/4.

Unlike tobacco, cotton production in our study area does not represent the dominant share of national production. While C.N.A. began operations over a decade ago, the other two companies in the area (DUNAVANT-Mozambique and COTTCO/Algodão do Zambeze) started only within the past three years. All together, the firms included in the survey sample (DUNAVANT-Mozambique-Tete and C.N.A./Northern Sofala) account for about 18,000 ha, or 11% of the national cotton area, and 14,000 tons, approximately 17% of the national production in 2003/4 (Figure 4). In the 2003/4 season C.N.A. worked with approximately 22,000 growers, while DUNAVANT-Mozambique operated with about 4,000.

Figure 4. DUNAVANT-Mozambique-Tete and C.N.A.-Northern Sofala in Total Area and Production 2003/4 Season



Source: DINA-MA and cotton companies

Overall, the performance of the cotton sub-sector in Mozambique has been far from satisfactory (World Bank 2005; Tschirley, Poulton, and Boughton 2006). Farmer profits remain well below potential due to very poor yields and low producer prices. In fact, Mozambique pays the lowest prices in the region; the 1998-2002 average producer prices were $0.16 per kilogram, compared to $0.22 in Zambia and Tanzania and $0.25 in Zimbabwe (Poulton et al. 2004). Yields in 2003/4 were 0.51 tons per ha, compared to 0.9 tons in Zimbabwe and over 1.0 ton in West Africa (Lemaitre, Fok, and Jeje 2001). While C.N.A. presents the best yield record in the country (over 0.8 tons/ha), it pays farmers statutory minimum prices, well below those in other countries. The other player in the sample, DUNAVANT-Mozambique, has only recently started operations. Its yields are still relatively low, but it makes an effort to retain farmers by paying prices well above the national average. Given its successful track record in Zambia, it is expected to play a key role in the development of the Mozambican cotton sector.

Further down the value chain, a large proportion of installed ginning capacity remains unutilized, and ginning outturns and lint quality are very low. Since the late 1990s, ginning outturns average 35% in the country, compared to 38% in Zambia, 40% in Zimbabwe, and 42% in West Africa (Lemaitre, Fok, and Jeje 2001; Ofiço and Tschirley 2003; Horus 2004; World Bank 2005).[5] As a result of its low quality, the price paid to Mozambique cotton in the

[5] More recently ginning outturns reached around 37%, with C.N.A. achieving as high as 41.5% in the 2001/2 season.

world market is significantly discounted relatively to the Index A price. Therefore, improvements in ginning quality and yields can have positive effects on the competitiveness of the sector by reducing lint production costs and improving export prices (World Bank 2005), increasing the prospects for better prices to farmers.

3. THE ORGANIZATION OF PRODUCTION AND TRADE IN COTTON AND TOBACCO SECTORS

3.1. Conceptual Framework

The approach used to analyze the organization of production and trade in this section follows Williamson in the sense that institutions are explicitly endogenized, particularly the process of institutional change and the choice and design of institutional arrangements (Williamson 1991). Institutions are central to economic development because they affect production and transaction costs (North 1990). In the presence of transaction costs and information constraints, institutions influence the efficiency and distribution of resources (Cook and Chaddad 2000). This approach is particularly relevant in developing countries, where high transaction costs, missing markets, and market failures[6] are the rule rather than the exception (Bardhan 1989).

The likely effect of agro-industrial investment on smallholder welfare is to some extent related to the nature of the institutional relationship (contractual form) between farmers and agro-industrial firms. Williamson (1991) identifies three broad types of contractual forms: neo-classical spot markets, bilateral contracts (where autonomous parties enter into contracts that extend beyond single transactions), and vertical integration within a firm.

Transactions underlie each of these institutional arrangements. In this context, transactions refer to the activities that allow or constrain transformation activities. A transaction occurs when two or more parties enter into an arrangement in which rights and obligations are exchanged (Staatz 1988). All transactions come bundled with a mix of characteristics—the degree of *asset specificity*, the degree and type of *uncertainty* to which the parties are subject to, and the *complexity* and *frequency* with which the transactions occur (Williamson 1991). For example, transactions which occur under isolated spot markets for low value commodities involve relatively low levels of all these characteristics. Transactions underlying a CF scheme have higher levels of these characteristics.

The mix of transaction characteristics is influenced by a number of factors related to production, marketing and processing characteristics, and to factors related to the economic and political environment (Jaffee and Morton 1995; Delgado 1999; Benfica, Tschirley, and Sambo 2002). Competitive forces tend to promote the emergence of forms of economic organization that minimize total costs of production and exchange in the economic system (Staatz 1988).

The analytical model used in this research is a simplified version, although following the same logic, of models used in much of the applied work in transaction costs economics (Klein 1995; Dorward 2001). The efficient form of organization for a given economic relationship, i.e., the likelihood of observing a particular organizational form, is a function of certain properties of the underlying transactions. Formally: $\boldsymbol{Y} = \Phi\ [\boldsymbol{X}]$, where, $\boldsymbol{Y}$ is a vector of alternative arrangements/organizational forms, more specifically: *Spot marketing, CF*

[6] Missing markets refer to a situation where there is no market to govern the allocation of resources or goods and services. Market failure is a situation in which markets exist but do not allocate resources efficiently. Market failure may be due to market power, externalities, public good nature of the goods or services, or the existence of incomplete or asymmetric information, and uncertainty.

alternatives, and plantation agriculture; and ***X*** is a vector of transaction characteristics that affect transaction costs, more specifically: condition and degree of *asset specificity*, degree and type of *uncertainty* that parties to the transaction are subject to, and *complexity and frequency* with which they occur.

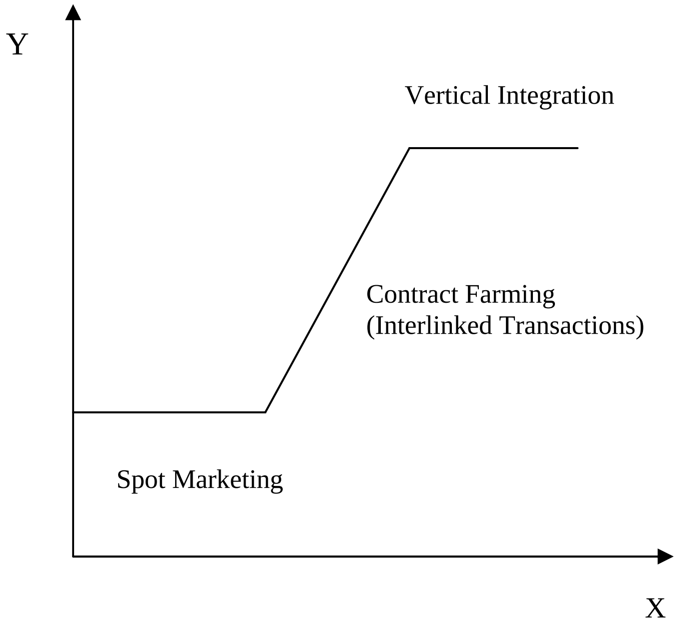
The probability of observing a more integrated organizational form depends positively on the amount or value of the specific assets involved in the relevant transactions, on the degree of uncertainty, the complexity of the transaction and its frequency (Klein 1995). In general, therefore, the greater the degree of asset specificity, the less likely it is that spot markets will be relied upon. In that case, contractors will seek to negotiate contracts that protect their investment in the face of external change. Figure 5 illustrates that low degrees of uncertainty, complexity, and frequency may favor spot markets and reduce the need for vertical coordination. The opposite, however, may lead to the recognized need of building contractual relationships that acknowledge mutual interest in contracting, facilitate information flows, and allow for a flexible joint response to changes in external circumstances; this includes a wide range of contractual arrangements.[7] But such relationships require trust. Where trust cannot be established, vertical integration may be chosen instead (Dorward, Kydd, and Poulton 1998).

The level of the elements in ***X*** is influenced by a number of factors related to production characteristics, marketing/processing characteristics, and the economic and political environment. Formally: $\boldsymbol{X} = \Omega(\boldsymbol{Z})$. Specific ***Z*** factors are introduced and explained in Table 3, and inference is made about favored arrangements in the presence of each factor. The framework is then used in the next section to show the degree to which these factors affect the choice of organizational form in the cotton and tobacco sectors in the Zambezi Valley of Mozambique.

Table 3 summarizes how each factor affects transaction costs and its implications for the type of institutional arrangement likely to result. In the next section we applied the same framework to the cotton and tobacco sub-sectors in the Zambezi Valley of Mozambique.

[7] As shown in Figure 5, spot marketing and full vertical integration are two extreme forms of organization; CF can be seen as a continuum, tending to either of the extremes depending on the terms agreed and the overall environment where it operates.

Figure 5. Organization of Production and Trade A Conceptual Framework



Y – Alternative institutional arrangements/forms of organization
X – Transaction characteristics: asset specificity, uncertainty, complexity and frequency

3.2. Contract Faming: Nature and Determining Factors

This section uses the analytical framework developed in the previous section to look at the major factors determining the current form of organization of production and trade in cotton and tobacco sectors in the Zambezi Valley of Mozambique. Note that CF is the sole form of organization observed for both sub-sectors in the region. Therefore, we started by defining that particular form of organization and characterize it for the case of the cotton and tobacco sub-sectors in the study region.

3.2.1. The Nature of CF Operations in Mozambique

In CF, farmers agree with processors/traders/exporters, through formal or informal contracts, to limit their production and marketing behavior in return for some level of service provision and purchase guarantee. These arrangements are best viewed in the Zambezi Valley of Mozambique, and in many parts of the developing world, as a response to missing institutions and widespread failure of input and credit markets and to poor or absent service provision. In addition to processors' need to ensure sufficient volume of purchases to reduce unit marketing and processing costs, concerns about product quality often significantly affect the structure of these relationships.

Table 3. Transaction Cost Factors and Institutional Arrangements

Factor	Effect on Transactions Costs	Type of Organizational Forms Most Favored: Spot Markets	CF	Vertical Integration
Production Characteristics				
High labor intensity	Increases supervision cost and requires capital saving/labor using technologies.	X	X	
Economies of scale	Requires high initial investment and high cash flow to be sustainable; generally not feasible for smallholders.			X
High returns to input, complex management	Requires effective research and extension, as well as timely availability of input.		X	X
Marketing/processing Characteristics				
High economies of scale in processing	Leads to the need for scale complementarity that creates strong incentives for stable supply of raw materials through more coordinated arrangements.		X	X
High quality standards	Increases returns to close vertical coordination.		X	X
High perishability	Increases the costs of not having a stable market. Increases returns to close vertical coordination.		X	X
High value to weight/volume	Increases risk of large loss in farm to market transaction.		X	X
Low value to weight/volume	Increases unit transport costs.			X
Principal market is export	Tends to reduce number of buyers and risk of default in CF; quality standards usually higher; greater economies of scale.		X	X
Many potential buyers	Increases cost and risk of default in CF.	X		X
Requires processing before final sale	Tends to reduce number of buyers and risk of default in CF.		X	X
Exogenous Economic and Political Factors				
Land scarcity/high population density	Increases land cost, political difficulties obtaining large tracts.	X	X	
Agriculture has a large share in the labor force	Increases land cost, political difficulties obtaining large tracts.	X	X	
Endogenous Economic and Political Factors				
Poorly integrated output markets	Increases procurement costs and marketing costs in general. Increases returns to coordination.		X	X
Missing input/factor markets	Non-availability of necessary production input limits reliance on spot markets and increases the returns to vertical coordination.		X	X
Poor communications	Raises cost of active vertical coordination, especially contract negotiation and enforcement.	X		X
Low literacy/educational levels among farmers	Raises cost of ensuring adoption of new production technologies/management practices; raises cost of collective action.	X		X
Weak property rights enforcement	Increases uncertainty with regard to reliance in contracts and the use of collateral. Increases the risk of default in CF.	X		
Weak local government	May make coordination more difficult; may be easier to accumulate large tracts of land.	X		X

Source: Author´s conceptualization and Benfica, Tschirley, and Sambo 2002

Both cotton and tobacco schemes take the form of *forward resource management contracts.* These contracts differ from the simple sale/purchase contracts because they include stipulations regarding the transfer and use of specific resources and/or managerial functions (Jaffee and Morton 1995). Forward resource management contracts partially internalize product and factor transactions, and are sometimes referred to as interlinked contracts or interlinked markets (Minot 1986; Glover and Kusterer 1990; Dorward, Kydd, and Poulton 1998). Given the current stage of development of rural agricultural input and credit markets in the country, farmers have little access to those resources. The contracts, designed to fill that gap, consist in the firms supplying seeds and chemical input on credit, along with technical assistance on specific areas of land. Farmers agree to utilize the input as instructed, and to sell all their production to the firms at harvest at pre-determined prices. Input costs are deducted at the time of the harvest/marketing. Given the lack of alternative contract enforcement mechanisms, the Mozambican Government has granted the agro-industrial firms legal monopsony power over specific geographic areas, referred to as *concessions*. Farmers in these areas are not permitted to sell to any but the concession holder. In the Zambezi Valley, production in these schemes takes place entirely on land "owned" by the individual farmers.[8]

3.2.2. Factors Leading to Interlinked Transactions

Many of the factors identified in Table 3 operate exactly the same way for both sub-sectors. Indeed, they are both dependent on quality raw materials for processing. High quality requires the use of on-farm chemical input and specific production techniques. In a country that has a high degree of failure in output, input and credit markets, and a poorly educated populace, reliance on spot markets for such crops is not feasible, and some degree of non-market vertical coordination is called upon to support and sustain these value chains. We then turned to an evaluation factor by factor. See Table 4 for the incidence of individual factors in each sector.

Production Characteristics: Current crop production technology in these sectors is characterized by high labor intensity, no economies of scale, and potentially high returns to input. In principle, particularly in a plantation setting, *high labor intensity* leads to high supervision cost in a principal agent setting. In addition, under a plantation arrangement, firms would have to pay the legal minimum wage for agricultural workers, generally set at a level higher than the informal wages paid to hired labor by smallholder growers and, for some cases, even above the implicit wage earned by cash crop growers. With CF labor, supervision is transferred to the HH. Given the relatively simple production technologies, the relatively high level of use of family labor and low level of hiring in cotton, HH level supervision cost is relatively low in CF for that crop. Tobacco uses more complex production techniques and more wage labor, but that wage labor tends to be relatively well trained, which reduces supervision costs.[9] *Economies of scale*, to be achieved and sustained, normally require high investment and cash flow which favors vertical integration.[10] *High returns to input* demand a great deal of detail in input use that requires some degree of coordination. In the current stage of development of the Zambezi Valley of Mozambique, *capital constraints* associated with a *poorly developed marketing system for input, output, and credit,* make CF the most feasible alternative to deal with the factors associated with crop production in these sub-sectors and the reduction in the resulting levels of uncertainty. The realization of this

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[8] In some other parts of the country, however, firms can also use designated areas or blocks within their own land concessions for that purpose (Strasberg 1997). Note that in Mozambique land is officially state owned, therefore non-tradable.

[9] Costs associated with labor supervision are more accentuated in a plantation setting relative to HH level management, as principal agent (manager-worker) problems, especially derived from adverse selection and moral hazard are far more intense when all workers have to be hired and work for a wage.

[10] Overtime, in the accumulation process, if returns are promising, contract farmers may have the incentive to invest in technologies that allow for the achievement of those economies of scale.

potential depends on the technological knowledge of farmers and on the level of coordination and organization of the outgrower firm extension systems.

Table 4. Incidence of Selected Factors in Cotton and Tobacco Sectors

Factor	Is the Factor Present? (Degree of incidence: +++, ++, +, -)[a] Cotton Sector	Tobacco Sector
Production Characteristics		
High labor intensity	+	+ + +
Economies of scale	+	+
High returns to input, complex management	+ +	+ + +
Marketing/processing Characteristics		
High economies of scale in processing	+ + +	+
High quality standards	+ +	+ + +
High perishability	-	-
High value to weight/volume	+ +	+ + +
Principal market is export	+ + +	+ + +
Many potential buyers	-	-
Requires processing before final sale	+ + +	+ +
Exogenous Economic and Political Factors		
Land scarcity/high population density	-	-
Agriculture has a large share in the labor force	+ + +	+ + +
Endogenous Economic and Political Factors		
Poorly integrated output markets	+ + +	+ + +
Missing input/factor markets	+ + +	+ + +
Poor communications	+ +	+ +
Low literacy/educational levels among farmers	+ +	+ +
Weak property rights enforcement	+ + +	+ + +
Weak local government	+ +	+ +

Source: Author conceptualization

[a] + + + Strong presence; + + Moderate presence; + Weak presence; - Absent

Processing and Marketing Characteristics: There are a number of factors related to processing and marketing/export characteristics that strongly favor the interlinkage of transactions in both sub-sectors. First, the two cotton firms in the region have a considerable amount of unused processing capacity and therefore need more raw product to exploit *economies of scale in processing*. In the tobacco sector all production is currently exported raw, but getting volume is as well important to achieve economies of scale in export. In both cases there is no competitive small scale processing option, so a system that can ensure volume is needed. Second, in both sectors, more so in tobacco at this point, the marketing system stresses *quality standards* and pays a premium for it. In principle, returns to firms and farmers can be increased with further quality differentiation. Since quality is strongly affected by how well and consistently production is managed, coordination mechanisms through CF are necessary. Third, the *high value to weight/volume* of these crops makes transport costs relatively cheap, especially for tobacco. If the products were *perishabl*e, this would increase the risk of high loss in farm-to-market transactions under an independent production system and favor a more coordinated approach. But both products are not perishable, so the high value to weight ratio, although important, has little influence over the organizational form governing transactions. Fourth, both crops are exported, which implies high returns to product quality that means potentially high returns to more effective coordination. Fifth, the presence of relatively few potential buyers and the need to process before final sale reduces the risk of default in CF. Without effective contract enforcement mechanisms in place, however, CF can be jeopardized. In theory, these two factors favor some form of non-market vertical coordination.

The bottom line is that dependence on quality output for processing that is highly dependent on proper use of chemical input in an environment where input markets are missing and human capital is relatively weak, makes reliance on spot markets infeasible. Full vertical integration (plantation arrangements) could be considered but the labor intensive nature of the production process makes labor supervision cost high. The statutory agricultural minimum wage that firms would have to pay to workers can also be a serious burden. This combination of factors renders some form of contract coordination the most feasible alternative in both sectors.

While CF allows these systems to function, asymmetric information and unbalanced bargaining power over issues such as prices and grading have emerged as barriers to its development. Furthermore, especially in cotton, low world prices, low ginning outturns, and low productivity at the farm level have constituted major constraints. These are, in part, consequences of a wide range of market and coordination failures and weaknesses in the concession system, many of which are beyond the scope of this study.

4. FARMER SELECTION/PERFORMANCE AND EFFECTS OF PARTICIPATION

The previous section identified the factors leading to the dominance of CF in the cotton and tobacco sectors in the Zambezi Valley. CF can be seen as a principal-agent game where a firm (the principal) works with a grower (the agent) to produce a crop. In this process, the firm chooses the farmers with whom it would like to contract and sets the contract terms. The firm's objective is to produce a given quantity of output while minimizing direct and indirect (transaction) costs. Farmers, in turn, will choose whether to participate. The combination of these choices describes the selection process for the CF scheme (Warning and Hoo 2000). The benefits participants accrue will depend on the terms of the contract and their own characteristics and endowments.

This section assesses the determinants of three related processes for each crop study area: farmer participation in the production of the cash crop, participants´ performance with the crop, and whether farmer participation, independently or associated to levels of land ownership and education attainment, has a significant impact on crop and total HH income. We first presented the study sampling coverage and descriptive statistics on scheme participants and non-participants in each concession area. Second, we formally presented the rationale for sample selection bias and the Heckman two-stage sample selection bias correction model. Finally, we presented the Farmer Scheme Performance Sample Selection Model, and the Treatment Effects Model specification, estimation, and results.

4.1. Study Area Sample and Comparison of Means

4.1.1. Survey Sample Coverage

The survey covered concession areas for four firms operating CF schemes in the Zambezi Valley of Mozambique: both tobacco firms operating in Tete Province-MLT, and DIMON-Mozambique, and two cotton companies, one operating in Tete Province (DUNAVANT-Mozambique) and the other operating in northern Sofala Province (C.N.A.). The survey targeted a total of 300 smallholder farmers: 180 in tobacco growing areas and 120 in cotton growing areas. Due to sample attrition, the final sample size for analysis was reduced to 276 observations: 159 smallholders for tobacco concession areas and 117 smallholders for cotton concession areas. In both areas the sample comprised both grower and non-grower smallholder HHs. More details on survey sampling are presented in Chapter 2 of Benfica (2006).

4.1.2. Comparison of Means

Two sets of descriptive statistics are presented as a comparison of means for three types of HH level variables: demographic characteristics, farm assets and use of hired labor, and levels of crop and HH income (total and *per capita*) along with prevalence and levels of selected income components. We also analyzed how the outcome variables—cash crop profits, crop and total HH incomes—vary across types of growers, by land holdings, and education attainment levels.

Results for the tobacco sector in Table 5 indicate that participants and non-participants are not statistically different in terms of demographic characteristics, such as HH size, labor endowments, education, and age of the HH head. HH headship is almost statistically significant with the likelihood for female headship relatively higher among non-growers. Also, differences are not statistically significant for the use of animal traction, and the rate of diversification into livestock and self-employment non-farm activities. Statistically significant differences exist for a number of variables. First are the total area owned, and total and *per capita* crop incomes, with growers having areas and agricultural income significantly larger, especially due to the cash crop. Note that net profits from tobacco average $730.74, i.e., 46.5% of total net agricultural income for that group. About 30% of tobacco farmers lost money during the survey year.[11] Second, as expected, tobacco growers own greater values of agricultural and marketing equipment (hand tools and other equipment, including bicycles). Third, tobacco growers are twice as likely to hire permanent labor.

Finally, non-growers have wage labor and non-farm self-employment incomes that are much higher in magnitude than those for tobacco growers, but those differences are not statistically significant. These differences partially compensate for the large difference in crop income and make the difference in total HH income less accentuated, but still significantly different in a statistical sense. It is consistently observed in Table 7 that tobacco profits among participating farmers increase with land holdings. The same pattern is observed for the relationship between net total crop and HH incomes across land holding quartiles for growers and non-growers in tobacco areas. Results with respect to education attainment are not so robust (Table 8). While it appears that cash crop profits are positively related to education, those differences vanish as one considers total crop and HH income in tobacco areas.

The comparison of means for the cotton sector is presented in Table 6. Results indicate that among demographic variables only that for educational attainment of the HH head is statistically different between the two groups.[12] Results suggest that non-grower smallholder HHs have higher formal educational attainment. Regarding farm asset variables, total area is the only variable that shows a statistical difference between growers and non-growers. However, due to the lower return to cotton and the fact that non-growers plant more maize and other crops, the difference does not translate into statistically significant differences in total and *per capita* crop incomes between the two groups. Net profits from cotton average $93.60, i.e., only 18% of the net agricultural income for that group. These average profits represent only 13% of those obtained by tobacco growers. However, contrasted to tobacco areas, where close to one-third of the growers lost money, only about 20% of cotton farmers lost money during the survey year.[13] Growers have on average more physical and livestock assets than non-growers, but the differences are not statistically significant.

[11] Results by firm indicate that the proportion was higher in MLT areas, about 36%, against 23% in DIMON-Mozambique areas.
[12] The HH age variable is close to significant, indicating that grower HH heads tend to be older than those in non-growing HHs.
[13] Results by firm indicate that the proportions were 19% among C.N.A. farmers, and about 21% among DUNAVANT-Mozambique farmers.

Table 5. Comparison of Mean Values for Selected Variables: Tobacco Growers and Non-growers

Selected Variables	Type of Farmers (mean values)		Statistical Significance of the Difference		
	Tobacco Contract Growers	Non-tobacco Growers	t-Stat	P > | t |	LS of the Difference [a]
Demographic Characteristics					
Female headed HHs (%)	5.13	11.90	- 1.49	0.14	.
Education of the HH head (years)	3.22	2.76	1.00	0.32	
Age of the HH head (years)	38.50	40.52	- 0.95	0.34	
Labor adult equivalents	3.45	3.68	- 0.88	0.38	
Farm Assets					
Total area (ha)	6.94	4.36	2.84	0.01	**
Value of manual tools ($US)	28.63	15.59	2.16	0.03	*
Value of equipment ($US)	66.60	36.63	2.58	0.01	**
Use of animal traction (%)	7.69	4.76	0.64	0.52	
Use of Hired Labor					
Permanent labor (% using)	71.79	30.95	4.98	0.00	**
Income Diversification (%)					
Livestock	93.98	96.15	- 0.44	0.66	
Self-employment	60.15	53.85	0.56	0.55	
Wage labor employment	24.81	53.84	- 3.03	0.00	**
HH Income ($US)					
Net HH income	1,815.28	1,022.48	2.35	0.02	*
Net HH income *per capita*	318.06	174.70	2.36	0.02	*
Net agricultural income [b]	1,572.70	595.47	3.11	0.00	**
Net agricultural income *per capita*	274.23	98.26	3.18	0.00	**
Wage labor income	80.76	122.35	- 0.92	0.36	
Self-employment (non-agricultural)	90.24	185.90	- 1.14	0.26	
Livestock income	90.11	79.50	0.35	0.73	
Number of Observations	117	42			

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

[a] Level of significance (LS): $^{+}$ at the 10% level, * at the 5% level, ** at the 1% level

[b] Net revenues from tobacco sales averages $730.74 among growers, i.e., 46.5% of net agricultural income

The use of permanent labor is generally limited in cotton growing areas, but, as expected, grower HHs are more likely to use that type of workers. However, differences between those two groups are not statistically significant. Estimated total and *per capita* income is higher for growers, but again, the difference is not statistically significant at 10% or lower levels. Likewise, non-growers appear to have off-farm income (both wage labor and self-employment) higher than growers.

Table 6. Comparison of Mean Values for Selected Variables: Cotton Growers and Non-growers

Selected Variables	Type of Farmers (mean values)		Statistical Significance of the Difference		
	Cotton Contract Growers	Non-cotton Growers	t-Stat	P > | t |	LS of the Difference [a]
Demographic Characteristics					
Female headed HHs (%)	5.74	6.67	- 0.18	0.86	
Education of the HH head (years)	2.60	3.40	- 1.88	0.06	+
Age of the HH head (years)	44.33	40.40	1.46	0.15	.
Labor adult equivalents	3.51	3.25	0.86	0.39	
Farm Assets					
Total area (ha)	3.97	2.81	2.58	0.01	**
Value of manual tools ($US)	12.94	11.81	0.61	0.54	
Value of equipment ($US)	46.75	33.44	0.97	0.33	
Use of animal traction (%)	5.75	6.67	- 0.18	0.86	
Use of Hired Labor					
Permanent labor (% using)	9.20	3.33	1.03	0.30	
Income Diversification (%)					
Livestock	90.11	88.46	0.24	0.81	
Self-employment	62.64	84.62	- 2.13	0.04	*
Wage labor employment	34.07	38.46	- 0.41	0.68	
HH Income ($US)					
Net HH income	732.40	574.64	1.21	0.22	
Net HH income *per capita*	124.89	108.57	0.76	0.45	
Net agricultural income [b]	518.24	364.50	1.50	0.14	.
Net agricultural income *per capita*	86.69	65.85	1.13	0.26	
Wage labor income	42.18	80.57	- 1.24	0.22	
Self-employment (non-agricultural)	32.15	56.02	- 0.60	0.55	
Livestock income	85.37	72.29	0.61	0.54	
Number of Observations	87	30			

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

[a] LS: $^{+}$ at the 10% level, * at the 5% level, ** at the 1% level

[b] Net revenues from cotton sales average $93.60 among growers, i.e., 18.1% of net agricultural income

These higher off-farm income for non-cotton growers and the resulting lack of significant difference in total income are consistent with previous studies in Mozambique (Tschirley and Weber 1994; Tschirley and Benfica 2001; Walker et al. 2004). In addition, mean values for wage labor and self employment income in Table 6 indicate that non-growers tend to have higher income from these sources, but the difference is not statistically significant. One may argue that these results suggest a relative degree of stagnation in these economies; the cotton income is not yet capable of pulling the rest of the economy into a dynamic mode.

Results in Table 7 indicate a positive, but weak, association between land holdings and profits from cotton sales. The relationship is more accentuated when it comes to overall crop and HH incomes, especially among non-cash crop growers. On average, returns to education (Table 8) appear much less important for cotton profits than for tobacco. The econometric analysis will shed more light on the significance of these indicative relationships.

Table 7. Mean Profits, Net Crop and Total Income by Land Area Quartiles

Quartiles of Land Area	Mean Land Area (ha)	Cash Crop Profits ($US)	Total Net Crop Income ($US) Growers	Total Net Crop Income ($US) Non-growers	Total Net Crop Income ($US) All Farmers	Total Net HH Income ($US) Growers	Total Net HH Income ($US) Non-growers	Total Net HH Income ($US) All Farmers
Tobacco Areas								
Quartile 1	2.28	184.7	562.0	175.6	417.1	726.7	533.5	654.2
Quartile 2	3.92	411.8	749.7	507.5	689.2	947.7	649.1	873.0
Quartile 3	6.12	462.1	1,499.0	846.8	1,298.3	1,684.1	1,227.1	1,543.5
Quartile 4	12.71	1,601.4	3,056.9	990.8	2,798.6	3,437.7	1,246.3	3,163.8
Total	6.26	730.7	1,572.7	543.5	1,300.8	1,815.3	844.0	1,558.7
Cotton Areas								
Quartile 1	1.72	76.6	302.5	231.3	271.7	458.4	381.8	425.2
Quartile 2	2.88	52.1	477.4	321.2	439.7	687.1	565.8	657.8
Quartile 3	3.70	81.4	486.3	418.1	474.5	747.0	720.8	742.5
Quartile 4	6.45	156.0	740.4	1,283.2	834.0	953.5	1,460.4	1,040.9
Total	3.67	93.6	518.2	458.7	503.0	732.4	661.0	714.1

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

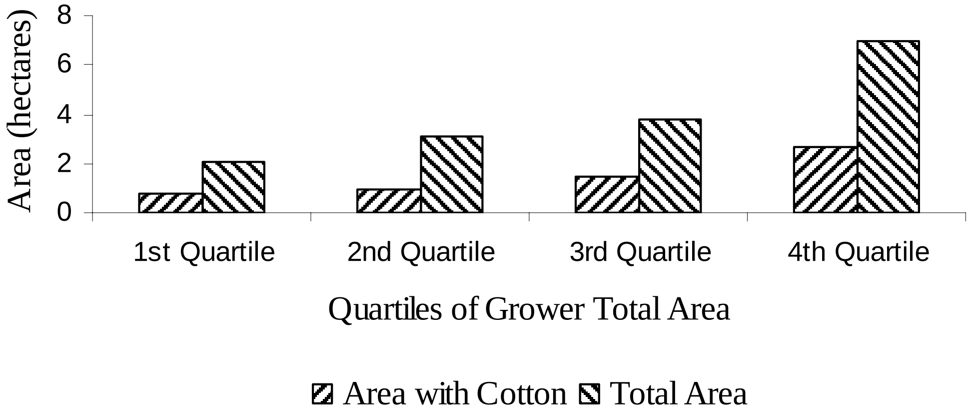
Table 8. Mean Profits, Net Crop and Total Income by Education Attainment Level

Years of Education of HH Head	Cash Crop Profits ($US)	Total Net Crop Income ($US) Growers	Total Net Crop Income ($US) Non-growers	Total Net Crop Income ($US) All Farmers	Total Net HH Income ($US) Growers	Total Net HH Income ($US) Non-growers	Total Net HH Income ($US) All Farmers
Tobacco Areas							
No schooling	554.9	1,472.4	377.0	1,126.5	1,594.4	659.29	1,299.1
1–3 years	731.5	1,695.0	669.4	1,446.9	1,931.2	887.35	1,678.7
4+ years	833.9	1,501.3	550.7	1,259.6	1,821.9	948.50	1,599.9
Total	730.7	1,572.7	543.5	1,300.8	1,815.3	844.03	1,558.7
Cotton Areas							
No schooling	65.9	652.5	211.0	564.2	1,005.6	483.3	901.1
1–3 years	90.4	426.6	342.5	408.8	519.3	508.0	516.7
4+ years	119.9	559.6	638.5	587.2	858.4	844.7	853.6
Total	93.6	518.2	458.7	503.0	732.4	661.0	714.1

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

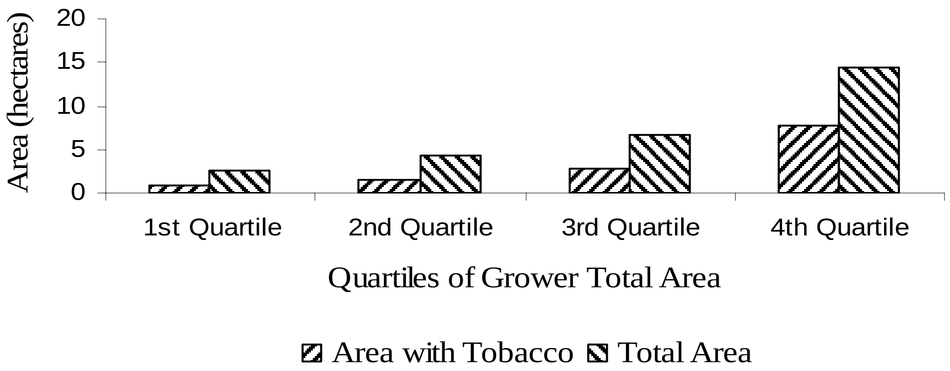
Figures 6 and 7 explore how area planted with cash crops relates to total area owned, by plotting both variables by total land area quartiles among cotton and tobacco growers.

Figure 6. Cotton Area Cultivated and Total Area Owned by Quartiles of Grower Total Area



Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

Figure 7. Tobacco Area Cultivated and Total Area Owned by Quartiles of Grower Total Area



Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

It is clear in both cases that area planted with the cash crop increases with total area owned. Correlation between the two variables is 0.76 among cotton growers and 0.92 among tobacco growers. It is worth noting that among cotton growers, the share of area planted with cotton in total area (across quartiles) is relatively flat: 38% (Quartile 1), 31% (Quartile 2), 37% (Quartile 3), and 39% (Quartile 4). Among tobacco growers those shares increase significantly between the lowest and the highest total area quartiles: 37% (Quartile 1), 37% (Quartile 2), 42% (Quartile 3), and 54% (Quartile 4).

4.2. Conceptual Framework

This section explains what determines the level of cash crop income (profit or loss) of participants and whether participation in CF schemes affect differences in total crop and HH income between growers and non-growers in tobacco and cotton growing areas of the Zambezi Valley, controlling for land endowments and education attainment threshold effects, as well as demographics, technology, and location fixed effects. Because cash crop income is only observed for a sub-set of the population, we ran into a sample selection problem usually referred to as incidental truncation, i.e., the observation of cash crop income depends on another variable, in this case, the participation in CF schemes.

To accurately estimate the determinants of cash crop income, and the effect of participation on total agricultural and HH income, we had to account for the fact that there may be unobservable factors that affect both the likelihood of participation in the schemes and the performance of participating farmers (Greene 2003; Warning and Key 2002). To control and correct for this possible sample selection bias, a standard sample selection model is used to access participation and within scheme performance, and a selection adjusted treatment effects model to assess if and how participation affects total crop and HH income levels.

4.2.1. Determinants of Cash Crop Income

Sample Selection Bias and Correction: A standard sample selection model is presented that explains and addresses the sample selection problem. Let the equation that determines sample selection be

$$c_i = \gamma z_i + e_i \quad , \qquad E(e \mid z) = 0 \qquad (1)$$

and the equation of primary interest be

$$y_i = \beta x_i + u_i \quad , \qquad E(u \mid x) = 0 \qquad (2)$$

where c_i is a dummy for participation, z_i is a vector of variables thought to affect the participation decision, y_i indicates the level of outcome of participants, x_i is a vector of variables assumed to affect the outcome, and e_i and u_i are disturbance terms. The model assumes $u_i \sim N(0, \sigma)$, $e_i \sim N(0, 1)$, and corr$(u_i, e_i) = \rho$.

Several assumptions are made. First, we assumed that the elements in x and z are always observed. Second, we assumed that (in addition to x) z is exogenous in (2), i.e., $E(u|x,z)=0$. Third, we required that x be a strict subset of z, with some elements of *z* not included in x (exclusion restrictions). Fourth, since the error term in the sample equation, e_i, is assumed to be independent of z, and x is a subset of *z*, then e_i is also independent of x. Finally, we assumed that e_i has a standard normal distribution (Wooldridge 1999; Wooldridge 2000).

Where does the bias come from? Correlation between the error terms u_i and e_i causes the sample selection bias. To see how, let us assume that (u_i, e_i) are independent of *z*. By taking the conditional expectation of (2) on z and e_i and considering that *x* is a subset of z, we have

$$E(y_i \mid z_i, e_i) = \beta x_i + E(u_i \mid z_i, e_i) = \beta x_i + E(u_i \mid e_i) \qquad (3)$$

Note that $E(y_i \mid z_i, e_i) = E(u_i \mid e_i)$ because (u_i, e_i) is independent of z. It follows that if u_i and e_i are jointly distributed with zero mean, then E($u_i \mid e_i$)=ρe_i for some parameter ρ, and replacing this in (3) we have

$$E(y_i \mid z_i, e_i) = \beta x_i + \rho e_i \quad (4)$$

Although we do not observe e_i, we can use this to compute $E(y_i \mid z_i, c_i)$, for c_i=1, and get

$$E(y_i \mid z_i, c_i) = \beta x_i + \rho E(e_i \mid z_i, c_i) \quad (5)$$

Taking into account the relation between c_i and e_i from Equation (1) and the fact that e_i has a standard normal distribution, it can be shown that $E(e_i \mid z_i, c_i)$ is simply the non-selection hazard, what Heckman (1979) referred to as the Inverse Mills´ Ratio (IMR), $\lambda(\gamma z_i)$, when c_i=1.

Thus:

$$E(y_i \mid z_i, c_i = 1) = \beta x_i + \rho\lambda(\gamma z_i) \quad (6)$$

Equation (6) indicates that the expected value of the outcome (y_i), given the set of characteristics z_i, and the observance of y_i when c_i=1 (i.e., the HH engages in CF) is equal to βx_i plus the IMR evaluated at γz_i. The equation indicates that we can estimate the parameters of interest, β´s, using only the selected sample, and that we should include $\lambda(\gamma z_i)$ as an additional regressor.

The parameter ρ defines the selection bias. If ρ=0, OLS of y on x using the selected sample gives consistent estimates of β. Otherwise, if ρ≠0, we have omitted a variable that is correlated with x_i. That is why Heckman (1979) points out that the presence of the selection bias can be viewed as an omitted variable problem in the selected sample. The parameter ρ will be equal to zero when u_i and e_i are uncorrelated.

Specification with Sample Selection Correction and Threshold Effects: Since γ is unknown, we cannot evaluate $\lambda(\gamma z_i)$ for each observation. The following is a summary of the procedure used in this paper, also known as the *Heckit Method*, named after the work of James Heckman.[14]

The first step uses all the observations in the sample to estimate the Probit Model of c_i on z_i,

$$\Pr(c_i = 1 \mid z_i) = \Phi(\gamma z_i) \quad (7)$$

[14] James J. Heckman received the Nobel Price in Economics in 2000 for his development of theory and methods for analyzing selective samples. http://nobelprize.org/economics/laureates/2000/index.html.

Equation (7) returns the estimates of γ, i.e., the determinants of participation in CF. The IMR (λ) is obtained from these estimates for each observation i, as $\lambda_i = \phi(\gamma z_i)/\Phi(\gamma z_i)$, where $\phi(\gamma z_i)$ and $\Phi(\gamma z_i)$ are the normal density and distribution functions, respectively.

The second step consists in running an OLS regression. The Net Cash Crop Income Determinants Model uses the selected sample, i.e., observations for which c_i =1, to run

$$y_i = \sum_{j=2}^{4} \alpha_j^0 A_{ji} + \sum_{k=2}^{3} \delta_k^0 E_{ki} + \beta x_i + \rho\lambda(\gamma z_i) + u_i \qquad (8)$$

where, y_i is the net cash crop income, A_{ji} are owned land area quartiles, E_{ki} are education attainment dummies, and x_i (other demographic, assets, technology, and locational factors) is a subset of z_i from the first stage.[15] Equation (8) returns estimates of the determinants of net cash crop income, α_j^0, δ_k^0, and β´s, and the sample selection bias coefficient ρ.

4.2.2. Effects of CF on Crop and HH Income

The Treatment Effects Model: The treatment effects model is an extension of the selectivity model presented in the previous section. It estimates the effect of an endogenous binary treatment on a continuous fully observed variable, conditional on the independent variables. In our case, it is the effect on total crop or HH income (y_i) of participation in CF operations (c_i). The primary regression of interest is

$$y_i = \beta x_i + \varphi c_i + e_i \qquad (9)$$

where c_i is a binary decision variable that stems from an unobservable latent variable that is assumed to be a linear function of the exogenous covariates and w_i and a random component u_i. Specifically,

$$c_i^* = \gamma w_i + u_i \qquad (10)$$

The decision to obtain the treatment (participate in CF) is made according to the rule

$c_i = 1$ if $c_i^* > 0$

$c_i = 0$, otherwise

where e_i and u_i are bivariate normal with mean zero and covariate matrix

$$Cov(e_i, u_i) = \begin{bmatrix} \sigma & \rho \\ \rho & 1 \end{bmatrix}$$

This model has many versions and has been applied in a variety of contexts (Barnow, Cain, and Goldberger 1981; Maddala 1983; Angrist 2001; Greene 2003). The model is estimated either by maximum likelihood estimation (MLE) or through a two-step procedure. The MLE can be time consuming with large datasets and the two-step estimation with consistent covariance estimates provides a good alternative (StataCorp 2003).

[15] Elements excluded from z_i are known as exclusion restrictions.

In the first stage of the two-step option (Maddala 1983), one obtains the probit estimates of the treatment equation

$$\Pr(c_i = 1 \mid w_i) = \Phi(\gamma w_i) \qquad (11)$$

From these estimates, the hazard, h_i, for each observation i is computed as

$$h_i = \phi(\gamma w_i)/\Phi(\gamma w_i) \qquad \text{if } c_i = 1\text{, and}$$

$$h_i = \phi(\gamma w_i)/[1 - \Phi(\gamma w_i)] \qquad \text{if } c_i = 0$$

where $h_i = \phi(\gamma w_i)$ and $\Phi(\gamma w_i)$ are respectively the density and distribution functions of the standard normal evaluated at *w*.

By taking the difference in the expected outcome between participants and non-participants in this model, $E[y_i \mid c_i = 1, x_i, w_i] - E[y_i \mid c_i = 0, x_i, w_i] = \varphi + \rho[\phi(\gamma w_i)/\Phi(\gamma w_i)(1 - \Phi(\gamma w_i))]$, it becomes clear that if the selectivity correction is omitted from the second step equation, the OLS will overestimate the effect of the treatment (Greene 2003).

Specification with Treatment and Threshold Effects: The Threshold Treatment Effects Model of CF on crop and HH income uses the full sample to run

$$y_i = \beta x_i + \varphi c_i + \sum_{j=2}^{4} \alpha_j^0 A_{ji} + \sum_{j=2}^{4} \alpha_j c_i A_{ji} + \sum_{k=2}^{3} \delta_k^0 E_{ki} + \sum_{k=2}^{3} \delta_k^0 c_i E_{ki} + \rho h_i(\gamma w_i) + u_i \quad (12)$$

where, y_i is total crop or total HH income, c_i is the participation dummy, A_{ji} refers to land holdings quartiles, E_{ki} are education attainment dummies, and h_i is the sample selection hazard variable. Both the land holdings and the schooling variables (A_{ji} and E_{ki}) are interacted with the participation dummy (c_i) to assess the effects of participation associated with land and education thresholds. The model generates OLS estimates of the average and threshold treatment effects coefficients φ, α's and δ's, the β´s (effects of other variables), and the sample selection bias coefficient ρ.

From the results of regressions (8) and (12), we can test for sample selection bias using the t-statistic on λ and h_i, respectively, as a test of H_0: ρ=0. Under the null hypothesis there is no sample selection bias.

4.3. Model Estimation and Discussion of Results

4.3.1. Farmer Participation and Performance in CF

The farmer selection/participation equation (Equation 7) is estimated using the entire sample. The dependent variable is a dummy equal to 1 if the farmer participates in the scheme and 0 otherwise. It is assumed that the likelihood of farmer participation is affected by four sets of factors: demographics, asset and factor endowments and technology, income diversification, and location. The variables associated with each factor follow.

Demographic Characteristics: The demographic variables include gender and age of the HH head, number of labor adult equivalents in the HH, and dummy variables for the level of formal education attained by the HH head. Education dummies include “no schooling” (excluded dummy), “1-3 years of schooling,” and “more than 3 years of schooling.”

HH Production Assets and Technology: These include quartile dummies of total area owned,[16] a dummy for the use of animal traction, the value of hand tools, and the value of other agricultural/marketing equipment, including bicycles.

Income Diversification Variables: It is hypothesized that HHs that have significant involvement in non-cash cropping activities will, given the constraints in labor and other endowments, be less likely to enter into cash crop contracts. To account and test for that, we included dummy variables for livestock, self-employment, and wage labor activities.

Spatial/location Variables: These variables are district-firm level fixed effects and are included to account for the differences across locations in the level of development, including natural resource endowments, physical and communications infrastructure development, and other factors. In tobacco areas, the district of Angónia (MLT area) and in cotton areas the district of Gorongosa (C.N.A. area) were dropped.

The farmer performance equation (Equation 8) uses only those farmers that participate in the CF schemes in each area. The dependent variable is the net value of cash crop income, i.e., after deducting the value of input provided on credit by the outgrower firm and wage labor costs.

The explanatory variables include all demographic variables, HH production assets and technology, all location variables as previously defined, and Lambda, $\lambda(\gamma z_i)$. If statistically significant, Lambda indicates and corrects for the presence of sample selection bias. All income diversification dummies were treated as exclusion restrictions, variables contained in the selection equation but assumed not to affect scheme performance.[17] Model results are presented in Tables 9 and 10 for tobacco and cotton areas, respectively.

Results for Tobacco Farmers: Probit results for tobacco CF areas in Table 9 indicate that HH participation in tobacco CF schemes is more associated with endowments, technology, and income diversification opportunities than with HH demographic characteristics. While point estimates indicate that female headed HHs are less likely to engage in tobacco production, the statistical significance of that result is not strong. Unexpectedly, results indicate (although without statistical significance at any relevant level) that HHs with more adult equivalents are less likely to engage in the contracts. A similar result was found by Warning and Key (2002) in their assessment of the ARB in Senegal.

The use of animal traction and the value of manual tools are positively associated with the likelihood of farmer participation in tobacco CF schemes. The value of other equipment, including bicycles, has a small positive, but statistically insignificant, effect. Also surprising, in light of the means comparisons in Table 5, is that HHs with more land are not more likely than others to grow tobacco.

The probit results suggest that HHs that have access to alternative sources of income are less

[16] Average land area for each quartile—across all HHs—is presented in Table 7.
[17] We tested the statistical significance of these variables and none were statistically significant in explaining the levels of cash crop income, but some were significant in explaining participation.

likely to directly participate in CF schemes in tobacco areas. HHs drawing income from livestock sales and wage labor are less likely to get engaged in tobacco production. This suggests that, if these options are sufficiently profitable, HHs will invest more family resources in those. This may help explain the result on the negative relationship between available adult equivalents and the likelihood of participation. Effectively, smaller HHs may rely on permanent wage labor and engage in tobacco, while larger HHs may draw resources into these activities, including selling labor to smaller HHs that choose to grow tobacco under contract. Education of the HH head does not statistically increase the likelihood of participation. The Model Pseudo-R^2 is 0.25.

The analysis of the determinants of tobacco net cash income in the second step does not indicate the presence of sample selection bias, i.e., the coefficient of lambda is not statistically significant at 10% or less.

Once HHs choose to engage in tobacco, some effects are worth noting. First, female headed HHs have mean net tobacco profits $400 lower than their male counterparts. Second, regarding farm endowments and technology, land has no effect on net tobacco income until the fourth land area quartile, when it has a large and highly significant effect. While at lower levels of land holdings (Area_Q2 and Area_Q3) the differences are not statistically significant, average profits of land rich HHs (Area_Q4) are $780 higher than that of their land poor counterparts (Area_Q1). The value of manual tools also has a positive partial effect on net tobacco income, although the effect of the variable is relatively small and only significant at the 10% level.

Third, there are no threshold effects of education on tobacco profits. This is a somewhat surprising result in a crop that is relatively intensive in management and production specificity. We investigated: (a) if there were any statistically significant relationship between land area and education, and (b) if education determines the level of self-employment and wage labor income. Results indicate that land and education of the HH head have a weak correlation coefficient of 0.11, and that, when running the profits determinants regression without the land area variables, the education variable remains statistically insignificant. These results lend credence to our original finding that returns to education are low, even in this demanding crop. Furthermore, a two-stage regression analysis on the determinants of off-farm income shows that education is an important determinant of both self-employment and wage labor income in tobacco growing areas, but only wage labor earnings (in the second stage) are statistically increased with increased educational attainment of the head. For detailed regression results, see Appendix A.

Table 9. Determinants of Profits from Tobacco Production

	Parameter Estimates							
	1st Stage: Participation [a]				2nd Stage: Net Income/tobacco			
Explanatory Variables	Coeff	Z	P > | z |	LS[b]	Coeff	t-stat	P > | t |	LS[b]
Demographics								
Female headed HH	- 0.375	0.84	0.40		- 405.56	1.95	0.05	*
Age of HH head	- 0.013	0.89	0.38		- 5.44	0.82	0.42	
Labor adult equivalents	- 0.154	1.29	0.20		106.51	1.26	0.21	
Education: 1-3 years	- 0.071	0.20	0.84		- 148.86	0.66	0.51	
Education: >3 years	0.024	0.06	0.95		17.55	0.07	0.94	
Assets and Technology [d]								
Area_Q2	0.333	0.92	0.36		247.07	1.36	0.18	

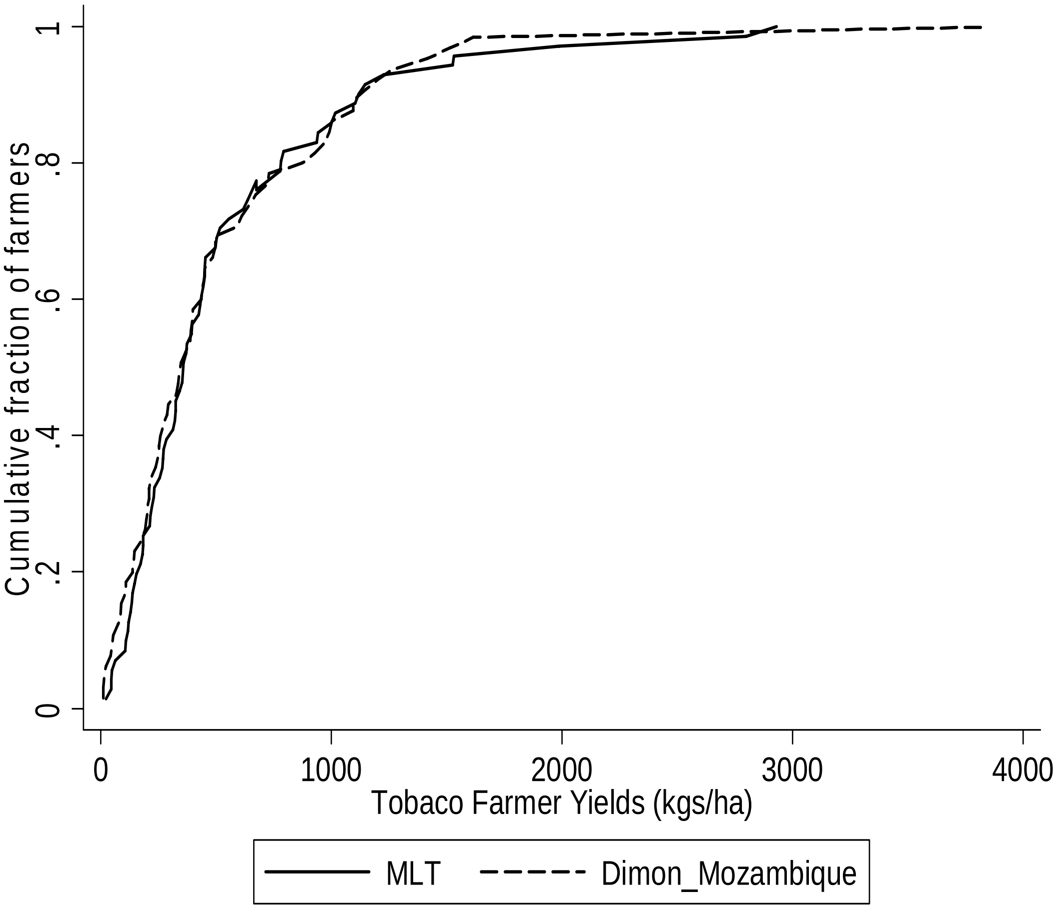
Area_Q3	0.027	0.06	0.95		- 78.32	0.34	0.74	
Area_Q4	0.500	0.96	0.34		780.34	2.30	0.02	*
Use of animal traction	1.198	2.35	0.02	*	198.83	0.48	0.63	
Value of manual tools	0.023	1.70	0.09	+	8.47	1.79	0.08	+
Value of other equipment	0.004	1.22	0.22		3.86	1.51	0.13	
Diversification Activities								
Has livestock income	- 1.026	1.90	0.06	+				
Has self-employment income	0.257	0.89	0.37					
Has wage labor income	- 0.879	2.88	0.00	*				
Agro-ecological Effects								
Mid-altitude								
Macanga/MLT	- 0.831	2.15	0.03	*	30.78	0.10	0.92	
Mualádzi/DIMON	0.161	0.43	0.67		83.19	0.41	0.69	
Angónia/MLT(dropped)								
Lower Altitude								
Marávia/MLT	- 0.361	0.85	0.40		- 600.79	2.68	0.01	**
Luia/DIMON	- 0.543	1.17	0.24		- 787.16	3.72	0.00	**
IMR (λ)					229.53	1.03	0.31	
Constant	1.544	1.85	0.07	+	- 170.74	0.41	0.68	
Number of Observations	159				117			
Wald chi2 (18)	45.25							
Prob > chi2	0.0004							
Pseudo R2	0.25							
Log pseudo-likelihood	- 81.62							
F (16, 100)					4.12			
Prob > F					0.0000			
R–Squared					0.46			
Root MSE					913.62			

Source: Zambezi Valley Tobacco Concession Areas Study 2004
[a] Probit equation for participation, 1 if participates, 0 otherwise
[b] LS: + 10%, * 5%, ** 1%
[c] No schooling (Education=0) is excluded
[d] Quartile 1 (Area_Q1) is excluded; profits and value of assets are expressed in $US.

Fourth, agro-ecology matters. Results suggest that farmers operating in north high altitude areas in Macanga (MLT) and Mualadzi (DIMON-Mozambique) have profits pretty much in line with those in Angonia (MLT), the omitted dummy, while those in Luia (DIMON-Mozambique) and Maravia (MLT) in the lower and drier south have profits statistically lower. For a comparison of yields and profits across firms, see the cumulative distribution functions (CDF) in Figures 8 and 9.[18] Overall, the OLS model has a good explanatory power, R^2 =0.46, and the F-test and the probability value are also highly significant.

[18] Data on farmer experience (number of years farmers have grown tobacco) were collected for the DIMON-Mozambique area. In firm specific sample regressions, both the linear and the quadratic specifications did not show any significant effects.

Figure 8. Cumulative Distributions of Tobacco Farmer Yields, by Firm, Zambezi Valley, Mozambique, 2003/4



Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

Figure 9. Cumulative Distributions of Tobacco Farmer Profits, by Firm, Zambezi Valley, Mozambique, 2003/4

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

Results for Cotton Farmers: Results for the sample selection model for cotton areas are presented in Table 10. The probit model in the first stage has a Pseudo—R^2 of 0.23. Model results indicate that choice of participation is inversely related to HH head's education. This result is consistent with findings in other cotton growing areas of Mozambique where more educated farmers tend to choose off-farm work over cotton. In sharp contrast with results in tobacco areas, HHs with larger land areas than the base group (land poor) are more likely to seek a contract in cotton; all the land holding threshold variables are positive and statistically significant.[19] The difference between the two sectors with this respect may be explained by the fact that, under current technological packages, in addition to land, participation in tobacco also requires the (unobserved) ability to manage production resources in a more complex set of field activities than what is required in cotton. In cotton, land is the single most important resource.

Consistent with expectations, access to alternative sources of income reduces the demand for cotton production contracts. Livestock income opportunities and self-employment are

[19] The similarity in magnitude in the coefficients of land thresholds Q2 to Q4 suggests that the threshold for getting into cotton lies around the 25th percentile, i.e., the greater difference is between the smallest 25% and everyone else.

negatively correlated with the likelihood of participation in CF; HHs do not appear to choose cotton if they have other good alternatives.[20] Expected low yields and cash returns in cotton production at this point contribute to this result. Note that even in C.N.A. areas where yields are considerably higher (see Table 2), cash returns are reduced by a more expensive input package and lower producer prices, the latter persistently set at the official minimum in recent years.

The regression results for farmer performance in the schemes show a p-value of 0.000 for the F-test of joint significance and an Adjusted R^2 of 0.64. The results indicate that the coefficient associated with the IMR is statistically significant at 5%, which indicates the presence of sample selection bias. Among the demographic variables, only the labor adult equivalent variable is statistically significant at 10%, indicating that once in the scheme, additional adults generate positive returns to cotton profitability; each additional adult adds, on average, $37 per year. Though not statistically significant, the coefficients on education achievement are positive. That is a rough indication that, although highly educated heads tend not to participate in cotton farming, the ones that do may be more likely to perform better than the less educated ones.[21]

Like in tobacco areas, no significant positive effects of total area owned on profits are observed until the fourth quartile; land rich cotton smallholders have profits that are about $150 higher than those of land poor cotton growers. This suggests that in order to benefit from the crop, smallholders need to be relatively large.

Furthermore, the value of production and marketing equipment is positively associated with returns to cotton growing. Finally, the analysis of district-firm fixed effects indicates that, controlling for other factors, average profits in all DUNAVANT-Mozambique areas are statistically lower than those in Gorongosa (C.N.A.). Only farmers in Maringue (C.N.A.) achieve higher profits than those in Gorongosa.[22] The cumulative distributions in Figure 10 indicate that yields for the C.N.A. farmers stochastically dominate those for the DUNAVANT-Mozambique farmers.

[20] Unlike in tobacco areas where labor demand is more pressing and labor markets are much more active, wage labor income does not compete with direct participation in CF in cotton areas.
[21] We tested and found that education and land holdings are uncorrelated. Also, returns to education in cotton growing areas are more sizable, though also not statistically significant, in non-farm self-employment activities. See Appendix A for detailed regression results.
[22] Information on the number of years farmers have grown cotton (experience) was collected for the DUNAVANT-Mozambique area. Both the linear and the quadratic specifications did not reveal any significant effects. Note that, since DUNAVANT-Mozambique operations started only a few years ago, not much variation is observed in the sample.

Table 10. Determinants of Profits from Cotton Production

	Parameter Estimates							
	1st Stage: Participation [a]				2nd Stage: Net Income from Cotton			
Explanatory Variables	Coeff	Z	P > | z |	LS[b]	Coeff	t-stat	P > | t |	LS[b]
Demographics [c]								
Female headed HH	- 0.594	0.95	0.34		13.140	0.15	0.88	
Age of HH head	0.002	0.16	0.87		- 1.070	0.61	0.55	
Labor adult equivalents	- 0.193	1.55	0.12		37.033	1.75	0.09	+
Education: 1-3 years	- 0.141	0.37	0.71		41.620	0.77	0.44	
Education: >3 years	- 1.079	2.54	0.01	**	85.253	1.36	0.18	
Assets and Technology [d]								
Area_Q2	1.137	2.82	0.01	**	8.700	0.16	0.87	
Area_Q3	1.400	3.12	0.00	**	- 3.310	0.05	0.96	
Area_Q4	1.212	2.36	0.02	*	148.887	2.00	0.05	*
Use of animal traction	0.507	0.62	0.53		97.614	0.65	0.52	
Value of manual tools	0.020	0.94	0.35		- 3.861	0.80	0.43	
Value of other equipment	0.002	0.52	0.61		1.279	3.59	0.00	*
Diversification Activities								
Has livestock income	- 0.887	1.75	0.08	+				
Has self-employment income	-1.104	3.11	0.00	**				
Has wage labor income	0.045	0.14	0.88					
District Fixed-Effects								
Chiúta/DUNAVANT	- 0.111	0.20	0.84		-566.612	7.22	0.00	**
Chifunde/DUNAVANT	- 1.085	1.98	0.05	*	-385.921	3.95	0.00	**
Moatize/DUNAVANT	0.101	0.22	0.83		-142.559	2.08	0.04	*
Caia/C.N.A.	0.229	0.48	0.63		-144.355	2.49	0.02	*
Maríngue/C.N.A.	- 0.104	0.20	0.84		18.698	0.26	0.79	
Gorongosa/C.N.A. (dropped)								
IMR (λ)					-154.986	2.09	0.04	*
Constant					205.148	1.39	0.17	
Number of observations	117				87			
Wald chi2 (19)	33.16							
Prob > chi2	0.02							
Pseudo R2	0.23							
Log pseudo-likelihood	- 62.57							
F (17, 69)					11.14			
Prob > F					0.00			
R–Squared					0.64			
Root MSE					193.90			

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004
[a] Probit equation for participation, 1 if participates, 0 otherwise
[b] LS: + 10%, * 5%, ** 1%
[c] No schooling (Education=0) is excluded
[d] Quartile 1 (Area_Q1) is excluded; profits and the value of assets are expressed in $US.

Figure 10. Cumulative Distributions of Cotton Farmer Yields, by Firm, Zambezi Valley, Mozambique, 2003/4

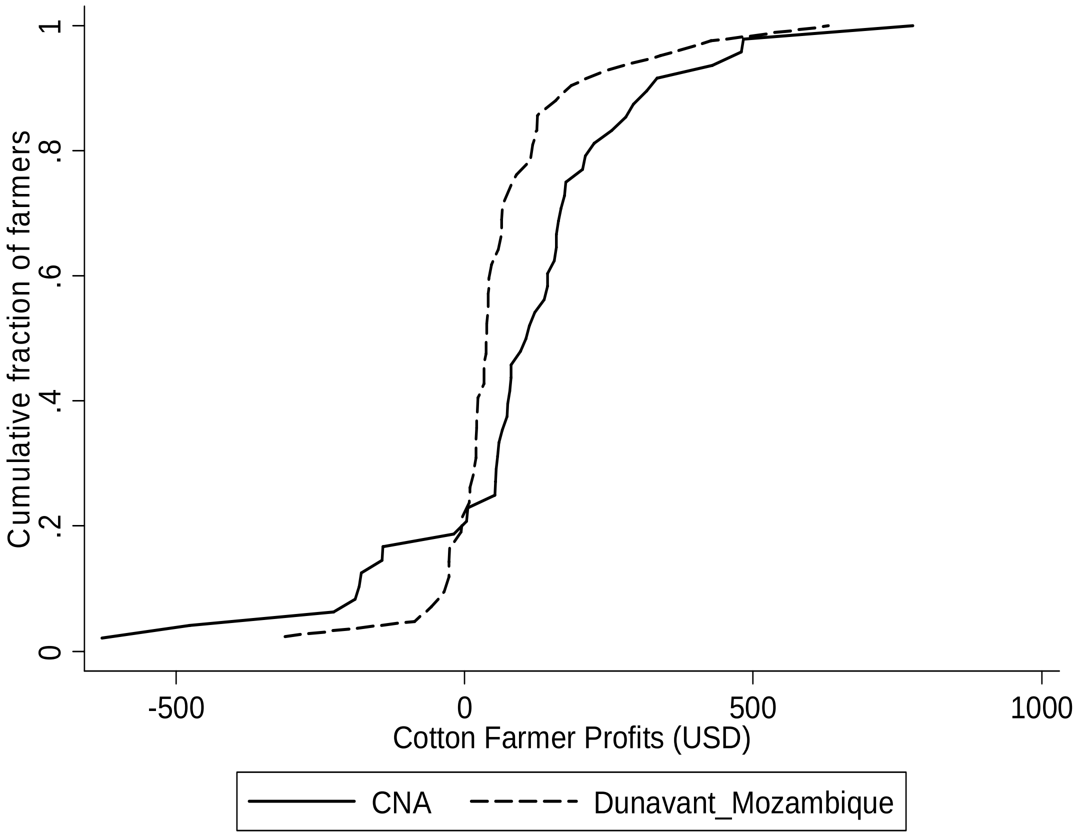
Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

Yet Figure 11 shows that, up to the 20th percentile of profits, C.N.A. farmers lose more money than DUNAVANT-Mozambique farmers; after the 20th percentile C.N.A profits are higher, but not by nearly as much as yields. This pattern is particularly due to the higher cost of the input package and the lower prices in the C.N.A. areas.

4.3.2. The Effects of CF on Crop and Total Income

The objective of this model is to assess whether farmer participation in the CF schemes in cotton and tobacco concession areas of the Zambezi Valley of Mozambique significantly explains differences in the level of crop income and total income of rural HHs. As previously, we explored threshold effects of land holdings and education.

Figure 11. Cumulative Distributions of Cotton Farmer Profits, by Firm, Zambezi Valley, Mozambique, 2003/4



Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

In spite of indications in section 4.1 that agricultural and HH income of participants, more significantly in tobacco areas, are higher than those of non-participants, we cannot yet attribute that difference to their participation in the schemes. Our analysis needs to take into account the possibility that the HHs that do participate in the schemes could have obtained higher income even if they had not chosen to participate, i.e., there may be factors that affect both their likelihood of participating in the schemes and their crop and HH income levels. That said, it is clear that assessing the impact of scheme participation by simply regressing crop income on the participation dummy variables using OLS could bias the estimate of the impact of participation. In this model, we considered two different OLS regressions in the second stage: one for net crop income determinants, and another for net total HH income determinants. The explanatory variables are similar in both regressions and include:

- *Treatment dummy for scheme participation* that takes the value 1 if the farmer participates in the CF scheme, and 0, otherwise;
- *Threshold effects interaction terms* between land holding quartiles and participation, and educational attainment classes and participation;
- *Spatial/location variables:* district dummies relevant for each area, and interactions between those and individual farmer participation status; and
- *Selection hazard variable*: $h_i(\gamma w_i)$, generated from the first stage probit estimation, separately for participants and non-participants.

In addition to these variables, we also included variables to account for *demographic factors* and *HH production/marketing assets and technology*, as defined in the profit determinants model.

Results for Tobacco Areas: The results of the treatment effects model are analyzed through the OLS output related to the second stage of the procedure applied to both agricultural income and total HH income.[23] In tobacco growing areas, average total crop income at the HH level is approximately $1,315 ($1,573 among growers and $596 among non-growers), while total HH income (crop plus income from farm and non-farm activities off the HH farm) is $1,606 ($1,815 among growers and $1,023 among non-growers). The same set of independent variables, as previously described, are used in both regressions. As shown in Table 11, the models for tobacco areas fit reasonably well, with an Adjusted R^2 of 0.44 for the crop income regression and 0.43 for the total HH income regression. Both regressions exhibit highly significant F-tests.

Several results stand out. First, the models find no return to education in crop income, regardless of a HH's participation status in the CF schemes. Education beyond three years does significantly increase total HH income of non-growers, reflecting higher off-farm earnings, particularly from wage labor, of more educated non-grower HHs. Participation in CF by such HHs almost entirely *offsets* this advantage, though this effect is not significant. These results are consistent with Walker et al. (2004) national analysis, and with Tschirley and Benfica (2001).

Second, two results stand out related to land holdings. First, participation in CF has no impact on crop and total HH income until the fourth quartile, when its effect is very large. Interaction effects of participation and land holding dummies are only statistically significant and sizable at the fourth quartile ($1,306 for crop income and $1,576 for total HH income). This result suggests the presence of important returns to tobacco production (at least within the land area sizes seen in this sample), perhaps through more efficient use of hired labor. If true, the result suggests the possibility of substantial growth in the coming years in the number of "emergent" or commercial smallholder HHs, driven by profit opportunities in tobacco. This class of farmers has been conspicuously lacking in Mozambique to date (Walker et al. 2004).

The ready availability of experienced labor in the area may be a key factor driving this result. Second, the relatively greater magnitude and significance of the coefficient on the fourth land quartile variable in the total income regression as compared to the crop income regression, suggests that even larger farmers appear to not be giving up on profitable off-farm income generating opportunities.

Third, female headed HHs earn lower crop income than their male-headed counterparts ($488 less), but differences in total HH income are negligible in magnitude and not statistically significant. This suggests that diversification into off-farm activities by female headed HHs reduces gender differentiation in income in those areas. Ownership of equipment beyond hand tools appears to increase agricultural income; though the coefficient is not quite significant in the agricultural income regression, it is significant in the total income model and its magnitude is nearly identical.

[23] Since we used exactly the same selection equation applied in the previous section, we are not emphasizing the probit results here.

Table 11. Effects of Tobacco CF on Net Crop and Net Total HH Income: Model with Land and Education Threshold Effects

Explanatory Variables [a]	OLS Parameter Estimates – Tobacco Areas							
	Net Total Agricultural Income				Net Total HH Income			
	Coef.	Robust S.E.	P |Z|>z	LS[b]	Coef.	Robust S.E.	P |Z|>z	LS[b]
Participates in CF	407.70	555.62	0.46		85.87	568.47	0.88	
Demographics								
Female head HH	- 488.01	239.68	0.04	*	0.66	282.52	0.99	
Age of HH head	4.85	10.32	0.64		15.85	11.04	0.15	
Labor adult equival.	25.44	98.06	0.80		- 3.99	105.43	0.97	
Education Threshold Effects [c]								
Education: 1-3 years	195.32	258.15	0.45		269.76	259.28	0.30	
Education: >3 years	361.14	312.48	0.25		718.92	320.28	0.03	*
[Education: 1-3]*CF	- 482.02	572.20	0.40		- 452.16	581.29	0.44	
[Education: >3]*CF	- 637.32	581.68	0.28		- 703.27	585.63	0.23	
Land Threshold Effects [d]								
Area_Q2	527.93	222.43	0.02	*	401.17	257.28	0.12	
Area_Q3	665.13	331.93	0.05	*	820.94	279.98	0.00	**
Area_Q4	723.32	396.06	0.07	+	691.65	359.09	0.06	+
Area_Q2*CF	- 129.33	349.50	0.71		4.26	377.02	0.99	
Area_Q3*CF	166.40	553.41	0.76		- 18.28	517.81	0.97	
Area_Q4*CF	1,305.86	631.67	0.04	*	1,575.96	652.95	0.02	*
Assets and Technology								
Use animal traction	- 56.43	601.06	0.93		- 275.33	620.81	0.66	
Value of tools	8.59	9.14	0.35		5.72	8.82	0.52	
Value of equipment	4.31	2.81	0.13		4.38	2.39	0.07	+
Use fertilizer in maize	12.99	250.38	0.96		- 22.13	244.14	0.93	
Agro-Ecological Effects								
Mid-altitude								
Macanga/MLT	165.83	371.25	0.66		- 159.92	345.50	0.64	
Mualadzi/DIMON	774.05	459.01	0.09	+	423.32	419.30	0.32	
Angonia/MLT	224.71	341.65	0.51		- 91.76	283.13	0.75	
Macanga/MLT*CF	662.23	722.84	0.36		942.34	722.45	0.19	
Muala/DIMON*CF	182.69	602.86	0.76		357.91	586.89	0.54	
Angonia/MLT*CF	141.48	553.88	0.80		265.72	545.30	0.63	
Lower Altitude								
Maravia/MLT	- 12.51	410.23	0.98		- 244.43	382.95	0.52	
Maravia/MLT*CF	90.38	772.74	0.91		36.57	760.10	0.96	
Luia/DIMON (excluded)								
Select. hazard ratio (h)	331.11	246.49	0.18		68.56	242.59	0.78	
Constant	- 1,101.09	793.64	0.17		- 679.39	773.48	0.38	
N	159				159			
F (27, 131)	4.11				4.92			
Prob > F	0.0000				0.000			
R–Squared	0.44				0.43			
Root MSE	1,207.00				1,258.10			

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

[a] OLS regressors

[b] LS: + 10%, * 5%, ** 1%

[c] No schooling (Education=0) is excluded

[d] Quartile 1 (Area_Q1) is excluded; crop income, total HH income, and the value of assets are expressed in $US.

Table 12. F-Tests of Joint Significance of CF and Education and Land Thresholds: Tobacco Areas

	Net Agricultural Income Regression				Net Total HH Income Regression			
	Combined Effect	F(2,131)	Prob>F	LS[a]	Combined Effect	F(2,131)	Prob>F	LS[a]
CF-Education Threshold Effects								
CF&[Education:1-3]*CF	(74)	0.40	0.67		(366)	0.40	0.67	
CF &[Education: >3]*CF	(229)	0.61	0.54		(617)	0.92	0.40	
CF-Land Threshold Effects								
CF&Area_Q2*CF	279	0.33	0.72		90	0.01	0.99	
CF&Area_Q3*CF	574	0.28	0.76		68	0.01	0.99	
CF&Area_Q4*CF	1714	2.26	0.10	+	1662	2.91	0.05	*

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004
[a] LS: [+] 10%, * 5%, ** 1%; the effects on net agricultural and net total HH income are expressed in $US.

District-level fixed effects are relatively weak. Results indicate that in terms of crop income among all HHs, only in Mualadzi (DIMON-Mozambique) are they statistically (and in magnitude) higher than those in Luia (DIMON-Mozambique). There are no participation-location effects in crop income, which suggest relatively balanced outcomes across participants in different locations. The coefficient of the selection hazard ratio is not statistically significant in either regression, which indicates that correction for the selection bias is not important in this model.[24]

Results for Cotton Areas: Results of the second stage OLS regressions for crop and HH income for cotton areas are presented in Table 13. In cotton growing areas, average HH total crop income is $479 ($518 for growers and $365 for non-growers), while total HH income (crop plus income from farm and non-farm activities off the HH farm) is $692 ($732 for growers and $574 for non-growers). F-tests of joint significance are highly significant, with R^2s of 0.60 and 0.48.

The results indicate that none of the demographic variables are statistically significant in either regression. The coefficient on the participation dummy—which reflects returns to cotton farmers in the lowest land and education classes—is positive in both cases, but is not statistically significant. Likewise, none of the participation land thresholds are statistically significant. This is somewhat consistent with earlier results, indicating relatively low productivity levels in cotton and some kind of food first strategy being carried out by both cotton growers and non-grower, with maize production clearly competing for HH labor and land resources. The end result is the prevalence of a situation where crop and total HH incomes between cotton growers and non-growers, after controlling for demographic, factor and asset/technology endowments, and spatial factors, are not significantly different.

We also found that the value of farm and marketing equipment (except manual production tools) is positively associated with higher crop and total HH incomes, but the magnitude of the effect is small. As expected, the value of manual tools is positively associated with crop income.

[24] In the analysis of the ARB Program, Warning and Key (2002) found a similar result regarding sample selection bias.

We knew that cotton yields are substantially higher in C.N.A. areas than in DUNAVANT-Mozambique areas (Figure 8); on the other hand, DUNAVANT-Mozambique has been paying better prices than C.N.A. Therefore, there is still plenty of room for improvement in both productivity and pricing. There is no evidence of participation district fixed effects.

The coefficient of the selection hazard variable is not statistically significant indicating the absence of sample selection bias in this model. Table 14 shows the F-tests of joint significance that assess the combined effects of participation per land and education thresholds. In all cases, the effects are not statistically significant.

Table 13. Effects of Cotton CF on Net Crop and Total HH Income: Model with Land and Education Threshold Effects

	OLS Parameter Estimates – Cotton Areas							
	Net Total Agricultural Income				Net Total HH Income			
Explanatory Variables [a]	Coef.	Robust S.E.	P |Z|>z	LS[b]	Coef.	Robust S.E.	P |Z|>z	LS[b]
Participates in CF	60.39	223.12	0.79		200.72	280.63	0.48	
Demographics								
Female head HH	- 61.67	110.41	0.58		- 55.45	169.74	0.75	
Age of HH head	1.37	3.18	0.67		2.60	4.14	0.53	
Labor adult equivalent	11.02	34.71	0.75		- 5.25	40.83	0.90	
Education Threshold Effects [c]								
Education: 1-3 years	99.30	157.58	0.53		107.91	187.02	0.57	
Education: >3 years	51.55	172.07	0.77		210.47	200.74	0.30	
[Education: 1-3]*CF	- 303.33	226.18	0.18		- 252.81	280.34	0.06	+
[Education: >3]*CF	- 257.31	280.30	0.36		- 436.22	399.59	0.28	
Land Threshold Effects [d]								
Area_Q2	116.97	137.16	0.40		296.49	174.84	0.09	+
Area_Q3	121.68	195.63	0.54		159.11	203.43	0.44	
Area_Q4	761.19	283.64	0.01	**	718.56	317.42	0.03	*
Area_Q2*CF	203.75	199.97	0.31		40.01	246.23	0.87	
Area_Q3*CF	152.56	257.67	0.56		322.72	271.95	0.24	
Area_Q4*CF	- 299.96	346.81	0.39		- 251.27	421.62	0.55	
Assets and Technology								
Use animal traction	- 241.37	241.81	0.32		- 21.69	299.43	0.94	
Value of tools	16.62	8.61	0.06	+	9.46	8.20	0.25	
Value of equipment	2.05	0.621	0.00	**	1.81	0.96	0.06	+
District Fixed-Effects								
Chiúta/DUNAVANT	18.15	238.88	0.94		81.18	250.80	0.75	
Chiúta/DUNAVANT*CF	- 388.82	329.28	0.24		- 14.51	388.62	0.97	
Chifunde/DUNAVANT	- 467.27	250.65	0.07	+	- 336.54	255.26	0.19	
Chifunde/Dunava*CF	17.70	282.44	0.95		- 22.32	349.12	0.95	
Moatize (DUNAVANT)	- 319.40	153.28	0.04	*	- 386.35	190.54	0.05	*
Moatize/DUNAVA*CF	136.96	199.60	0.49		309.95	236.99	0.20	
Caia /C.N.A.	- 154.97	169.11	0.36		113.87	242.03	0.64	
Caia/C.N.A.) *CF	139.27	229.78	0.55		- 86.24	313.12	0.78	
Maríngue/C.N.A.	52.32	157.32	0.74		140.00	212.27	0.51	
Maríngue/C.N.A.*CF	28.79	222.47	0.90		30.20	283.82	0.92	
Gorongosa/C.N.A.(excluded)								
Select. hazard ratio (h)	106.59	150.70	0.48		160.53	202.70	0.43	
Constant	16.921	249.33	0.95		66.02	277.75	0.81	
N	117				117			
F (28, 88)	11.18				5.00			
Prob > F	0.00				0.00			
R–Squared	0.60				0.48			
Root MSE	389.03				500.91			

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004
[a] OLS regressors
[b] LS: + 10%, * 5%, ** 1%
[c] No schooling (Education=0) is excluded
[d] Quartile 1 (Area_Q1) is excluded; crop income, total HH income, and the value of assets are expressed in $US.

Table 14. F-Tests of Joint Significance of CF and Education and Land Thresholds: Cotton Areas

	Net Agricultural Income Regression				Net Total HH Income Regression			
	Combined Effect	F(2, 88)	rob>F	LS[a]	Combined Effect	F(2, 88)	Prob>F	LS[a]
CF-Education Threshold Effects								
CF&[Education:1-3]*CF	(242.94)	1.24	0.30		(52.09)	2.12	0.13	
CF&[Education: >3]*CF	(196.91)	0.45	0.64		(235.50)	0.60	0.55	
CF-Land Threshold Effects								
CF and Area_Q2*CF	264.15	0.54	0.58		240.74	0.28	0.76	
CF and Area_Q3*CF	212.95	0.30	0.74		523.45	1.21	0.30	
CF and Area_Q4*CF	(239.56)	0.44	0.65		(50.54)	0.48	0.62	

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study Survey 2004

[a] LS: + 10%, * 5%, ** 1%; the effects on net agricultural and net total HH income are expressed in $US.

5. SUMMARY OF POLICY IMPLICATIONS

Tobacco and cotton concessions in the Zambezi Valley of Mozambique have provided a secure source of cash income to the rural population in areas where alternative income generating activities are limited. This section looks at some key issues in each sub-sector as they relate to the results of the analysis presented in this paper and elaborate on its policy implications.

Key results and implication from the econometric analysis in the *tobacco sector* relate to the impact of education, land holdings, access to wage labor, issues related to labor migration, and the effects of environmental and technological spillovers. First, the lack of return to education in a crop as demanding as tobacco is surprising. Perhaps the best interpretation is that great scope remains for improving field practices, yields, and profitability. As companies strengthen their extension efforts and more farmers have more time to learn proper techniques, we expected more educated farmers to begin earning higher returns from tobacco.

Second, results on land holding size and access to wage labor may tell an interesting story. Tschirley and Benfica (2001) showed that those with wage labor income, especially those at the high end of this market, tend to maintain such income for long periods of time. Boughton et al. (2005) showed that most income growth throughout the country over the past six years has come from off-farm income, especially wage labor. The research in this paper shows that HHs with such income are less likely to grow tobacco; HHs *without* such income are the ones taking advantage of the tobacco opportunity. As a result, tobacco cultivation may reduce income inequality. However, many smaller farmers earn negative profits from tobacco, while larger farmers tend to earn large positive profits. Over time, this pattern could drive substantial expansion in the number of "emergent" smallholder farmers in the area. Those left behind will be the smaller farmers who also have little access to wage labor opportunities.

Third, recent expansion in tobacco production has been possible due in part to the readily available labor knowledgeable of tobacco cropping, especially in border areas. Survey data suggest that two-thirds of the 61% of farmers with permanent workers employ at least one worker labelled as Malawian.[25] Many of these are former tobacco smallholders in Malawi that find the wage labor opportunities in Mozambique more profitable. The likelihood of a farmer employing this type of labor increases with area, and the profits and HH income of farmers that hire Malawian labor tend to be above those that do not do such hiring. Approximately 25% of total payments to wage laborers in the area go to this group. In terms of our model, these patterns raise concerns about possible consumption leakages. Yet, over 75% of the so called "Malawians" report spending 9 to 12 months working in Mozambique, which suggests that a great deal of their annual consumption takes place in Mozambique. In practice, then, our results suggest two things. First, income leakage is not likely to be a major problem. Second, availability of Malawian labor is important to the growth of the sector. One policy implication is that efforts to ensure that Malawi migrants gain some kind of permanent residency that leads them to spend more time and resources in Mozambican territory can be helpful both to feed expansion of the sector and to spread benefits in the local economy.

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[25] Evidence suggests that this labor force is a mixture of returned refugees (established in Malawi during the Mozambique Civil War), family members of these returnees, and a genuinely new generation of Malawian migrant laborers.

Finally, technological and environmental spillovers in tobacco growing areas need to be more closely examined. On the positive side, growers and non-growers both are far more likely to apply fertilizer on food crops than are farmers in other areas of the country. It is likely that the provision of fertilizer for tobacco has contributed to this pattern, through a combination of some diversion to food crops[26] and greater familiarity with the input leading to greater use. On the negative side, the rate of tree cutting by tobacco growers far surpasses the rate of planting (Benfica et al. 2005). Long term consequences could be quite negative if these trends are not halted. Specific action to contain or reverse the situation is, therefore, required.

In the cotton sector, results from our analysis are in line with several other studies in the cotton sector that have emphasized low prices and poor productivity at the farm level as factors leading to the stagnation of cotton farmer income in Mozambique (World Bank 2005; Tschirley, Poulton, and Boughton 2006); Mozambique pays the lowest prices in Africa, and farmer yields are also among the lowest. Our study clearly documents the low profitability of the crop relative to tobacco in the Zambezi Valley region. The concession model as applied in Mozambique, which precludes competition among companies and does not balance this with any effective performance monitoring system, must be considered an important contributor to the problem of low prices and also low productivity. Resolving this problem through more sophisticated management of the concession system has to be a high priority for the government and other stakeholders over the next few years.

In this study we found, through our econometric analysis, that increased profits in cotton can be achieved with increased farm size and a higher level of production assets. However, there are no landholding threshold effects on income from all crops, nor on total HH income. This seems to suggest some stagnation in these economies, where cotton activity is not yet capable of pulling the rest of the economy into a dynamic mode through strong economic linkages. Again, these results are quite different from those found for tobacco areas.

Improving the contribution of cotton to smallholder livelihoods in Mozambique requires a host of improvements in the quality of the seed stock, systems for treating seed prior to distribution to farmers, improved input packages linked to effective extension with farmers, and improved pricing. The entrance of new companies into the sector such as DUNAVANT-Mozambique—with a good productivity and pricing record in Zambia—and C.N.A., with an impressive productivity record in Mozambique, holds the promise of improved results for smallholder farmers. These results, however, have so far not been delivered for most farmers. Reforms to the concession model currently in place would seem to be a requirement for significant future progress. Because many alternative approaches to reform are possible, informed research on reform paths, linked to some kind of participatory stakeholder process, should receive high priority among both public and private groups interested in the sector, and in smallholder welfare.

[26]We do not know how common such diversion is.

APPENDIX A
SELECTED OUTPUT TABLES

Table A.1. Determinants of MSE Income, Two-Stage Model in Tobacco Areas

Explanatory Variables	Parameter Estimates							
	1st Stage: Has MSE Income [a]				2nd Stage: Net MSE Income			
	Coeff	z	P > | z |	LS[b]	Coeff	t-stat	P > | t |	LS[b]
CF	0.251	0.88	0.38		-532.02	1.33	0.19	
Demographics [c]								
Female headed HH	-0.452	0.90	0.37		-334.92	1.59	0.12	
Age of HH head	0.036	2.47	0.01	**	0.27	0.05	0.96	
Labor adult equivalents	-0.215	1.76	0.08	+	-44.73	0.74	0.46	
Education: 1-3 years	1.029	2.76	0.01	**	95.56	0.42	0.67	
Education: >3 years	0.909	2.52	0.01	**	538.93	1.51	0.13	
Assets and Technology [d]								
Area_Q2	1.009	2.72	0.01	**				
Area_Q3	0.319	0.73	0.45					
Area_Q4	0.208	0.42	0.67					
Use of animal traction	-0.763	1.48	0.14					
Value of manual tools	-0.003	0.64	0.52					
Value of other equipment	-0.001	0.42	0.68					
Fertilizer in maize	0.007	0.02	0.98					
Agro-ecological Effects								
Mid-altitude								
Angónia/MLT	-0.321	0.64	0.52		111.98	0.72	0.47	
Muládzi/DIMON	-0.134	0.28	0.78		733.94	1.37	0.18	
Macanga/MLT	0.161	0.33	0.74		-99.95	0.40	0.69	
Lower Altitude								
Marávia/MLT	- 0.477	0.82	0.42		-161.37	0.64	0.52	
Luia/DIMON (dropped)								
IMR (λ)					-130.79	0.31	0.76	
Constant	-1.312	1.65	0.10	+	411.82	0.70	0.48	
Number of observations	159				94			
Wald chi2 (17)	30.60							
Prob > chi2	0.02							
Pseudo R2	0.17							
Log pseudo-likelihood	- 90.24							
F (11, 82)					0.60			
Prob > F					0.82			
R–Squared					0.25			
Root MSE					842.08			

Source: Zambezi Valley Tobacco Concession Areas Study 2004
[a] Probit equation for participation, 1 if has MSE income, 0 otherwise
[b] LS: + 10%, * 5%, ** 1%
[c] No schooling (Education=0) is excluded
[d] Quartile 1 (Area_Q1) is excluded; MSE income and value of assets are expressed in $US.

Table A.2. Determinants of Wage Labor Income, Two-Stage Model in Tobacco Areas

	Parameter Estimates							
	1st Stage: Has Wage Labor [a]				2nd Stage: Wage Labor Income			
Explanatory Variables	Coeff	z	P > | z |	LS[b]	Coeff	t-stat	P > | t |	LS[b]
CF	-0.781	2.55	0.01	**	144.11	0.95	0.35	
Demographics [c]								
Female headed HH	1.713	3.06	0.00	**	437.26	2.82	0.01	**
Age of HH head	-0.018	1.16	0.25		2.68	0.58	0.56	
Labor adult equivalents	-0.276	2.14	0.03	*	58.88	1.42	0.17	
Education: 1-3 years	0.122	0.30	0.76		52.76	0.69	0.49	
Education: >3 years	0.715	1.79	0.07	*	408.92	2.71	0.01	**
Assets and Technology [d]								
Area_Q2	-0.715	1.79	0.07	*				
Area_Q3	0.116	0.27	0.79					
Area_Q4	0.584	1.19	0.23					
Use of animal traction	0.324	0.52	0.60					
Value of manual tools	-0.004	0.81	0.42					
Value of other equipment	-0.001	0.34	0.74					
Fertilizer in maize	0.435	1.16	0.25					
Agro-ecological Effects								
Mid-altitude								
Angónia/MLT	- 0.277	0.61	0.54		-200.97	1.41	0.16	
Mualádzi/DIMON	-1.454	2.71	0.01	**	-125.97	0.77	0.44	
Macanga/MLT	-0.786	1.57	0.12		-313.96	2.04	0.05	*
Lower Altitude								
Marávia/MLT	-0.636	1.17	0.24		-419.57	2.59	0.01	**
Luia/DIMON (dropped)								
IMR (λ)					-30.86	0.19	0.85	
Constant	1.830	2.19	0.03	*	-130.39	0.77	0.45	
Number of observations	159				47			
Wald chi2 (17)	49.12							
Prob > chi2	0.00							
Pseudo R2	0.29							
Log pseudo-likelihood	-76.27							
F (11, 35)					5.90			
Prob > F					0.00			
R–Squared					0.53			
Root MSE					254.24			

Source: Zambezi Valley Tobacco Concession Areas Study 2004

[a] Probit equation for participation, 1 if has wage labor income, 0 otherwise

[b] LS: [+] 10%, * 5%, ** 1%

[c] No schooling (Education=0) is excluded

[d] Quartile 1 (Area_Q1) is excluded; wage labor income and value of assets are expressed in $US.

Table A.3. Determinants of MSE Income, Two-Stage Model in Cotton Areas

Explanatory Variables	Parameter Estimates							
	1st Stage: Has MSE [a]				2nd Stage: Net MSE Income			
	Coeff	z	P > | z |	LS[b]	Coeff	t-stat	P > | t |	LS[b]
CF	-1.057	3.56	0.00	**	48.87	0.90	0.37	
Demographics [c]								
Female headed HH	-0.896	1.34	0.18		62.70	1.06	0.30	
Age of HH head	-0.005	0.40	0.69		-0.09	0.06	0.95	
Labor adult equivalents	-0.155	1.43	0.15		-48.51	1.08	0.29	
Education: 1-3 years	-0.007	0.02	0.99		-74.18	1.34	0.18	
Education: >3 years	-0.453	1.08	0.28		37.90	0.74	0.46	
Assets and Technology [d]								
Area_Q2	0.153	0.40	0.69					
Area_Q3	0.911	2.16	0.03	*				
Area_Q4	0.134	0.27	0.79					
Use of animal traction	0.502	0.67	0.51					
Value of manual tools	0.022	1.22	0.22					
Value of other equipment	-0.002	0.80	0.43					
Agro-ecological Effects								
Chiuta/DUNAVANT	0.383	0.81	0.42		53.06	0.57	0.57	
Chifunde/DUNAVANT	0.058	0.12	0.90		9.15	0.13	0.90	
Caia/C.N.A.	0.071	0.17	0.87		143.65	1.40	0.17	
Moatize/C.N.A.	0.542	1.16	0.25		-1.12	0.02	0.99	
Maríngue/C.N.A.	-0.415	0.87	0.38		103.42	0.71	0.48	
Gorongosa (dropped)								
IMR (λ)					-98.55	0.77	0.45	
Constant	1.725	2.30	0.02	*	209.13	1.93	0.06	+
Number of observations	117				79			
Wald chi2 (17)	35.43							
Prob > chi2	0.01							
Pseudo R2	0.19							
Log pseudo-likelihood	- 55.94							
F (12, 66)					0.78			
Prob > F					0.67			
R–Squared					0.21			
Root MSE					189.41			

Source: Zambezi Valley Tobacco Concession Areas Study 2004

[a] Probit equation for participation, 1 if has MSE income, 0 otherwise

[b] LS: + 10%, * 5%, ** 1%

[c] No schooling (Education=0) is excluded

[d] Quartile 1 (Area_Q1) is excluded; MSE income and value of assets are expressed in $US.

Table A.4. Determinants of Wage Labor Income, Two-Stage Model in Cotton Areas

Explanatory Variables	Parameter Estimates							
	1st Stage: Has Wage Labor [a]				2nd Stage: Wage Labor Income			
	Coeff	z	P > | z |	LS[b]	Coeff	t-stat	P > | t |	LS[b]
CF	0.117	0.35	0.73		-96.76	1.72	0.10	**
Demographics [c]								
Female headed HH	0.120	0.19	0.85		420.58	2.54	0.02	*
Age of HH head	-0.017	1.06	0.29		-8.41	2.92	0.01	**
Labor adult equivalents	0.042	0.33	0.74		65.23	3.42	0.00	**
Education: 1-3 years	0.388	0.86	0.39		-99.75	0.74	0.47	
Education: >3 years	-0.070	0.14	0.89		-158.69	1.42	0.17	
Assets and Technology [d]								
Area_Q2	-0.272	0.61	0.54					
Area_Q3	-0.487	0.98	0.33					
Area_Q4	-0.024	0.04	0.97					
Use of animal traction	0.595	0.75	0.45					
Value of manual tools	-0.010	0.40	0.69					
Value of other equipment	-0.003	1.09	0.28					
Agro-ecological Effects								
Chiuta/DUNAVANT	2.196	3.30	0.00	**	402.11	1.42	0.17	
Chifunde/DUNAVANT	2.539	3.56	0.00	**	466.82	1.47	0.15	
Caia/C.N.A.	1.871	3.04	0.00	**	352.73	1.34	0.19	
Moatize/C.N.A.	1.666	2.65	0.01	**	316.03	1.37	0.18	
Gorongosa/C.N.A. (dropped)								
IMR (λ)					241.23	1.31	0.20	
Constant	-1.261	1.29	0.20		-159.27	0.37	0.72	
Number of observations	98				41			
Wald chi2 (18)	25.61							
Prob > chi2	0.0598							
Pseudo R2	0.26							
Log pseudo-likelihood	-49.11							
R–Squared					0.48			
Root MSE					160.86			

Source: Zambezi Valley Tobacco Concession Areas Study 2004
[a] Probit equation for participation, 1 if has wage labor income, 0 otherwise
[b] LS: + 10%, * 5%, ** 1%
[c] No schooling (Education=0) is excluded
[d] Quartile 1 (Area_Q1) is excluded; wage labor income and value of assets are expressed in $US.

Table A.5. Selected Characteristics of Zambezi Valley Smallholder HHs

	Cotton Areas					Tobacco Areas				
	Type of Farmers (mean values)		Statistical Significance of the Difference			Type of Farmers (mean values)		Statistical Significance of the Difference		
	Non-growers	Growers	t-Stat	P > | t |	LS[a]	Non-growers	Growers	t-Stat	P > | t |	LS[a]
Demographic Characteristics										
HH size	5.4	6.0	1.11	0.27		6.0	5.9	-0.35	0.73	
Female headed HHs (%)	6.7	5.7	-0.18	0.86		11.9	5.1	-1.49	0.14	
Education of the HH head (years)	3.4	2.6	-1.88	0.06		2.8	3.2	1.00	0.32	
Education of HH adults (years)	4.3	3.8	-1.10	0.27		4.0	4.5	1.05	0.29	
Age of the HH head (years)	40.4	44.3	1.46	0.15		40.5	38.5	-0.95	0.34	
Labor adult equivalents	3.2	3.5	0.86	0.39		3.7	3.5	-0.88	0.38	
Farm Assets										
Total area (ha)	2.8	4.0	2.58	0.01	**	4.4	6.9	2.84	0.01	**
Reported value of manual tools ($US)	11.8	12.9	0.61	0.54		15.6	28.6	2.16	0.03	*
Reported value of equipment ($US)	33.4	46.8	0.97	0.33		36.9	66.6	2.58	0.01	**
Use of animal traction	6.6	5.7	-0.18	0.86		4.7	7.7	0.64	0.52	
Use of Hired Labor										
Permanent labor (% using)	3.3	9.2	1.03	0.30		31.0	71.8	4.98	0.00	**
Use of Chemical Input										
Fertilizer – maize	0.0	0.0	-	-		21.4	32.5	1.35	0.18	
Fertilizer – vegetables	0.0	0.0	-	-		7.1	12.0	0.86	0.39	
Income Diversification (%)										
Livestock	90.0	90.0	0.05	0.96		95.2	94.0	-0.29	0.77	
Self-employment	86.7	60.9	-2.65	0.01	**	47.6	63.2	1.77	0.08	+
Wage labor employment	40.0	33.3	-0.66	0.51		47.6	23.1	-3.01	0.00	**
HH Income ($US)_										
Net HH income	692.4	872.7	1.27	0.21		1,170.8	2,060.1	2.68	0.01	**
Net agricultural income	364.5	518.2	1.50	0.14		595.5	1,572.7	3.11	0.00	**
Net HH income per capita	108.6	124.9	0.76	0.45		174.7	318.1	2.36	0.02	*
Net agricultural income per capita	65.8	86.7	1.13	0.26		98.3	274.2	3.18	0.00	**
Wage labor income	80.6	42.2	-1.24	0.22		122.3	80.8	-0.92	0.36	
Self-employment (non-agricultural)	56.0	32.1	-0.60	0.55		185.9	90.2	-1.14	0.26	
Number of observations	30	87				42	117			

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study 2004

[a] LS: + 10%, * 5%, ** 1%

Table A.6. The Structure of HH Income in the Zambezi Valley Smallholder Economy

Income Components	Cotton Growing Areas						Tobacco Growing Areas						All Zambezi Valley Region	
	Non-growers		Growers		All Area		Non-growers		Growers		All Area			
	$US	%	$US	%	$US	%	$US	%	$US	%	$US	%	$US	%
1. Agricultural Income	490.2	63.3	658.5	78.6	615.3	74.7	743.8	70.8	1,817.5	86.4	1,533.9	82.3	1,144.5	79.1
1.1. Food crops	490.2	63.3	473.5	54.7	477.8	56.9	743.8	70.8	944.5	48.1	891.4	54.1	716.1	55.3
1.1.1.Retained food	446.2	59.5	448.7	51.9	448.1	53.9	654.7	63.6	911.7	46.3	843.8	50.9	676.1	52.1
1.1.2. Sold food	43.9	3.8	24.8	2.8	29.7	3.0	89.1	7.2	32.7	1.8	47.6	3.2	40.0	3.2
1.2. Cash crops	0.0	0.0	185.0	23.9	137.6	17.8	0.0	0.0	873.1	38.3	642.5	28.2	428.4	23.8
2. Livestock	72.3	14.2	85.4	10.4	82.0	11.4	79.5	8.6	90.1	5.8	87.3	6.5	85.1	8.6
3. Self-employment	56.0	10.8	32.1	5.2	38.3	6.7	185.9	7.5	90.2	3.8	115.5	4.8	82.8	5.6
4. Wage Labor	80.6	12.8	42.2	4.0	52.0	6.2	122.3	10.6	80.8	4.9	91.7	6.4	74.9	6.3
5. Transfers/pensions	0.0	0.0	70.7	3.9	52.6	2.9	64.6	4.1	25.7	1.3	36.0	2.1	43.0	2.4
6. Remittances/net	(6.6)	(1.1)	(16.2)	(2.2)	(13.8)	(2.0)	(25.3)	(1.8)	(44.2)	(2.1)	(39.2)	(2.0)	(28.4)	(2.0)
6.1. Received	17.7	2.4	10.3	1.7	12.2	1.8	10.2	1.5	13.2	1.0	12.5	1.1	12.4	1.4
6.2. Sent	(24.3)	(3.6)	(26.6)	(3.8)	(26.0)	(3.7)	(35.6)	(3.2)	(57.4)	(3.1)	(51.7)	(3.1)	(40.8)	(3.4)
HH Income														
Total ($US/HH)	692.4	100.0	872.7	100.0	826.5	100.0	1,170.8	100.0	2,060.1	100.0	1,825.2	100.0	1,401.8	100.0
Per capita ($US)	108.6		124.9		120.7		174.7		318.1		280.2		212.6	
Number of Observations	30		87		117		42		117		159		276	

Source: Zambezi Valley Cotton and Tobacco Concession Areas Study 2004

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