The Economics of Tobacco Farming in Zambia

Presentation Version

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EXECUTIVE SUMMARY

Tobacco is the key ingredient in a set of products that if used as suggested by the manufacturers will kill more than half its users. Mitigating tobacco use should therefore be a cornerstone of any government's public health strategy. Yet, tobacco control consistently faces enormous opposition, often from opponents using arguments with a supposed economic logic.

The alleged harm to tobacco farmers from tobacco control policies has become one of the ubiquitous reasons promoted by the tobacco industry and its allies for governments to slow, stop or even reverse tobacco control efforts. Moving beyond the well substantiated logic that demand for tobacco is driven by global, not country-level, consumption – Zambia's tobacco control efforts will have little or no short-run effect on farmers – it is not at all clear if tobacco farming is even a livelihood worth pursuing for Zambians. Accordingly, in this report, we utilize a representative survey of nearly 500 tobacco farmers to examine their economic livelihoods.

In brief, we find that in the best-case scenario, the livelihood of a small-hold tobacco farmer is rarely an improvement on growing most other crops. In fact, in the vast preponderance of cases, growing tobacco is actually far worse than most agricultural livelihoods. The results of our research suggest that particularly the tobacco farmers who have signed contracts with leaf-buying companies to cultivate tobacco leaf are **typically operating at a net loss when the principal (non-labour) inputs (which they borrow through their contracts) are subtracted from the sales of their tobacco leaf**. The farmers usually end up in debt to the leaf-buying company, compelling them to grow tobacco again the following season, precipitating or continuing a long and generally losing cycle. To make this scenario even worse, tobacco growing is one of the most labour-intensive crops – **if you include even a conservative estimate of labor costs, the plight of most tobacco farmers looks even more bleak**. Most tobacco farmers would be better off putting their very hard work into another pursuit.

Zambia is a Party to the WHO Framework Convention on Tobacco Control, which compels parties to help tobacco farmers to find viable alternative livelihoods (Article 17). But it is much more than just the government's commitment to this international treaty, it is really about the government's commitment to economic development for all Zambians. The results of this research suggest strongly that finding and promoting alternative livelihoods for tobacco farmers should be a development priority in the coming years.

INTRODUCTION

One of the most preventable causes of premature death in the world is tobacco use. More than six million deaths each year are attributable to using tobacco products, which is more than HIV/AIDS, tuberculosis and malaria combined (Forouzanfar et al., 2015). The World Health Organization predicts that this number will rise to 8.4 million deaths a year by 2020, and the preponderance of those most affected by this problem live in low- and middle-income countries (LMICs) (WHO, 2015).

Worldwide, there are almost 2 billion people who already smoke, or who will smoke when they reach adulthood, and more than half of all regular cigarette smokers are eventually killed by their habit — unless they quit. Even in middle age, stopping smoking prevents most of the risk of being killed by tobacco, and stopping earlier avoids almost all of it. There are two additional important elements to consider: age of initiation and the nature of addiction. The initiation of tobacco smoking occurs almost always early in life, typically by the age of 18. Unfortunately, the nicotine in tobacco products is one of the most addictive substances on this planet. Tobacco control then – including both getting people to quit and preventing others from starting – is one of the key public health challenges of the first half of the 21st century.

In Zambia, tobacco use prevalence in adult males is more than 20% (Zambia Demographic Health Survey, 2015). At 1.6%, it is lower in women, but the latest Global Youth Tobacco Survey (GYTS) and the most recent wave of the International Tobacco Control (ITC 2015) Project survey results indicate that a higher proportion of girls than boys in Zambia now use tobacco products, suggesting a major and potentially catastrophic shift (GYTS 2011; ITC 2015). These percentages equate to more than one million adult smokers and more than 56,000 child and youth smokers (tobaccoatlas.org). Moreover, tobacco is not just a health issue, it is also a development one. Buying tobacco instead of using resources to obtain other vital goods and services like healthcare and education prevents families from rising out of poverty (Chelwa and Van Walbeek, 2014). In order to smoke 10 of the cheapest cigarettes per day, a Zambian of average income would have to spend nearly 20% of his or her income (tobaccoatlas.org).

Despite tobacco control's status as a public health "best buy" – it saves millions of lives and is relatively inexpensive – it continues to face stiff opposition in many countries, including in Zambia. One of the most common reasons against tobacco control efforts is the alleged threat to the economic livelihoods of tobacco farmers posed by these policies and activities. Even though it is well established empirically

that demand for tobacco leaf is global and a country's tobacco control efforts are unlikely to affect tobacco farmers' livelihoods in the short term, this argument against tobacco control continues to resonate. Moreover, too little information exists about these livelihoods in most countries, with almost no information about Zambian farmers in particular. In reality, it is not even clear what kinds of livelihoods can be derived from growing tobacco leaves. It is therefore one of the central goals of this report to examine more systematically the economic livelihoods of Zambian tobacco farmers.

It is also important to note that Article 17 of the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) – to which Zambia is a Party – obligates:

> Provision of support for economically viable alternative activities Parties shall, in cooperation with each other and with competent international and regional intergovernmental organizations, promote, as appropriate, economically viable alternatives for tobacco workers, growers and, as the case may be, individual sellers.

Knowing the context of tobacco farming will better equip policymakers to address the issue of generating viable alternatives to tobacco farming compelled by this article.

Though agriculture makes a relatively small contribution to the country's Gross Domestic Product (GDP), it employs the preponderance of people. In excess of 66% of Zambia's population relies on agriculture as a source of livelihood (Tembo and Sitko, 2013). Agriculture's contribution to GDP has steadily declined over the years representing broader structural changes in the economy. In 2001, agriculture's contribution to GDP stood at 16% but by 2012, it was 12% (ibid.). The contribution of the agriculture sector that excludes forestry and fishing was even lower at 7% in 2012.

Tobacco is one of a handful of export-oriented agricultural commodities in Zambia, along with cotton, tea, coffee and more recently, maize. In the 2012 season, the latest year for which we have comparable figures, tobacco production contributed 0.4% of GDP (Food and Agriculture Organization, 2015; World Development Indicators, 2015). The contributions to GDP of maize, cotton, coffee and tea were respectively 1.5%, 0.7%, 0.1% and 0.01% (ibid.). In the same year, Zambia produced a total of 34,000 tons of tobacco valued at $98 million (Food and Agriculture Organization,

2015). On the other hand, total output of maize, cotton, coffee and tea was respectively 2.9 million tons, 260,000 tons, 6,500 tons and 900 tons (ibid). The value of production for maize, cotton, coffee and tea in 2012 was respectively $390 million, $180 million, $17 million and $2 million (ibid.).

The total area planted for tobacco in 2012 was 59,000 hectares (Food and Agriculture Organization, 2015). Most of the tobacco grown in Zambia, about 70%, is the flue-cured Virginia type and almost all of the rest is Burley (Tobacco Board of Zambia, 2015). Comparable figures of area planted for maize, cotton, coffee and tea were respectively 1.2 million hectares, 316,000 hectares, 7,000 hectares and 650 hectares (Food and Agriculture Organization, 2015; Tembo and Sitko, 2013). The number of small and medium scale farmers engaged in growing tobacco in 2012 was estimated at 10,000 (Tembo and Sitko, 2013). For maize, cotton and coffee comparable numbers for 2012 were respectively 1.2 million, 280,000 and 195 (ibid.).

In order to examine tobacco farmer livelihoods, a major individual-level economic survey of farmers was implemented in 2015, led by researchers at the University of Zambia School of Medicine, in collaboration with the American Cancer Society. Data collection interviews with 497 farmers were conducted during the period, 1-15 February, 2015. Training in data collection for 11 Research Assistants was conducted for 3 days prior to the fieldwork. The training included a field pre-test component after which the survey instrument was modified to account for concerns raised. The study was conducted in six (6) districts of Zambia where tobacco is mostly grown by small- to medium-scale farmers, namely: Chipata and Lundazi in Eastern Province (197 farmers); Kapiri and Serenje in Central Province (84 farmers); and Kalomo and Choma in Southern Province (216 farmers). With the assistance of District Agriculture Coordinators (DACO), pockets of tobacco farmers were identified in each target district. Because agricultural authorities do not register tobacco farmers, there was not a pre-existing record of which farmers grow tobacco. Accordingly, after agricultural extension officers initially identified small-holder tobacco farmers in each major tobacco-growing sub-district, a snowball sampling method was used in which farmers identified other tobacco farmers within each of the selected sub-districts until the sample size goal of 500 survey respondents was met.

RESULTS

Socio-Demographic Characteristics of the Study Population

Table 1 presents many of the key socio-demographic characteristics of the survey respondents. Most of the tobacco farmers interviewed were male (80.1%). Note, however, that farming is commonly a family activity, in which both males and females participate and this result does not necessarily accurately represent the proportion more broadly of who works on tobacco farms. Most farmers were between 36 and 60 years old, were married (82.5%) and had primary schooling (52.1%).

Table 1 – Socio-Demographic Characteristics of Survey Respondents

Characteristic	N=497	Percent
Province		
Central	84	16.9
Eastern	197	39.6
Southern	216	43.5
Gender		
Male	398	80.1
Female	99	19.9
Age (Years)		
< 21	9	1.8
21 – 35	191	38.4
36 – 60	297	59.8
Marital Status		
Single	57	11.5
Married Monogamous	347	69.8
Married Polygamous	63	12.7
Divorced	14	2.8
Widowed	16	3.2
Education		
No Education	20	4.0
Primary	259	52.1
Secondary	211	42.5
Tertiary	7	1.4
Primary Occupation		
Farming (Crop and Livestock)	478	96.2
Salaried employment	5	1.0
Self-employed (off farm)	2	0.4
Casual Worker	2	0.4
Business (non-farm)	8	1.6
Other	2	0.4

Table 2 presents data on household size. Tobacco-growing households are larger compared to the national average of 5 (Central Statistical Office, 2012). Tobacco growing households also tend to have larger household sizes when compared to the average for all agricultural households. The average household size for all agricultural households was estimated at 5.4 (Central Statistical Office, 2006). The median overall size was 8 persons, with an equal male/female split (4/4). Most household comprise a median number of household members of 3 aged in the range 19 to 64 years, suggesting that most household members were 18 years of age or under. This age composition is broadly consistent with the general Zambian demographic picture of a young population.

Table 2 – Number of People in Households by Age Group

				Age Range				
	Total	**Females**	**Male**	**< 5**	**5 – 10**	**11 – 18**	**19 – 64**	**> 65**
Median	8	4	4	2	2	2	3	0
Minimum	1	0	0	0	0	0	0	0
Maximum	38	18	30	8	7	10	21	8

Table 3 presents data on the main sources of livelihood of the survey respondents. 80% (400 of 500) respondents reported tobacco crop production as their primary source of livelihood. Of the respondents 71.2% (356 of 500) reported other crop production as their secondary source.

Table 3 – Main Source of Livelihood

	Primary	Secondary	Third
Crop production (Tobacco)	400	90	7
Crop production (other crops)	96	356	30
Livestock production	7	12	136
Natural resources sales	0	0	3
Formal employment	2	0	3
Casual labour (ganyu)	6	5	20
Beer brewing	0	0	2
Petty trading/business	13	10	61
Gifts/Remittances	0	0	1
Pension	0	0	1
Artisanal skills	2	2	8

The results in Table 4 demonstrate that the majority of tobacco farmers in the survey were on contract (73.6%) with a leaf-buying company. Typically, the contract arrangement provides to the farmers the required agricultural inputs while also providing a guaranteed buyer for their product. Notably, there were no guaranteed prices, not even a price minimum. Just over two-thirds of contract farmers reported the name of the leaf-buying firm with which they had a contract, and the main contractors were Tombwe Processing (75 farmers) and Standard Commercial (64 farmers).

Table 4 – Type of Tobacco Farming Enterprise

Type of Farmer	N	Percentage
Contract	331	71.8
Independent	130	28.2
Total	461	100.0

Of these farmers, 18.0% of the independent tobacco farmers grew the crop as members of a cooperative, while 73.5% of the contract tobacco farmers grew the crop as members of a cooperative. In terms of the type of tobacco cultivated, 69.6% of independent farmers and 63.7% of contract tobacco farmers grew Virginia tobacco. These numbers tally closely with those from the Tobacco Board of Zambia referenced above. All but seven of the remaining farmers grew Burley tobacco (3 contract farmers grew NDDF, 3 contract farmers grew SDF while one independent farmer grew NDDF). On average, it took the contract tobacco farmers 9.8 months to produce the tobacco, while it took the independent farmers 10. 4 months. In terms of curing, 95.3% of the independent farmers and 99.5% of the contract farmers reported having curing barns, and the most common method of curing the tobacco was by fire for both independent (39.8%) and contract (44.3%) farmers. In terms of experience, the independent farmers had an average of 6.6 years of growing experience, while contract tobacco farmers had an average of 9.2 years. While the survey results cannot reveal the precise reasons for both the above-average age of the farmers (>36, and older than the general population) and the relatively short tenure growing tobacco, we hypothesize that this dynamic is partly a consequence of structural reform programs that removed support to farmers growing mainly food crops (e.g. groundnuts, maize, etc.). The tobacco-buying companies entered the market during or shortly after this time and filled the void – a pattern that the broader increases in annual tobacco production corroborate. As the government increases the scope of subsequent programs like the Farm Input Subsidy Program (FISP), it will be important to see how

farmers respond, particularly whether they return to growing crops more consistent with increasing food security.

In terms of the actual contracts, 69.8% of contract farmers reported that they were adequately informed about the contract into which they had entered, and 93.3% of them reported signing a formal, written contract with the tobacco-buying firms. About 14.2% of the tobacco farmers on contract were offered the possibility of getting a cash advance from the tobacco firm.

The Economics of Growing Tobacco

As illustrated in Table 5, on average, the surveyed tobacco farmers sold 1,272.1 kilograms of tobacco leaf in the 2013/14 season, but it diverged significantly between contract and independent farmers. Contract farmers sold an average of 1454.6 kilograms, while independent farmers sold an average of 863.2 kilograms.

Average incomes also varied between the groups. The overall average of tobacco-related income of the survey respondents was 8345.79 Kwacha ($1464.18 US dollars using the Economist Intelligence Unit data of 2013 USD-KMW exchange rate), which accounted on average for 63.59% of total income. Contract farmers generated an average of 9431.04 Kwacha ($1654.57 USD) tobacco-related income, which accounted on average for 68.78% of their total income ($2,405.60); while for independent farmers, it was an average of 6094.78 Kwacha ($1069. 26), which accounted on average for 47.69% of their total income ($2,242.11).

The reported prices that farmers received for their tobacco leaf also diverged between the two groups. Tobacco leaf buyers typically offered contract farmers somewhat higher prices per kilogram – USD $2.95 versus $2.45 for independent farmers.

Table 5 – Average Production, Price and Income

	Quantity(kg) of leaf	**Average price (USD)**	**Reported tobacco income(USD)**
Contract	1454.6	2.95	1654.57
Independent	863.2	2.45	1069.26
All	1272.1	2.82	1464.18

Some farmers chose not to answer the sales and income questions. There were valid responses from 62.2% (311 out of 500) of respondents for the quantity of sale question and 71.2% (356 out of 500) valid responses for the income question.

Statistical tests suggest that the non-responses may not have been completely random. Farmers allocating more land for tobacco farming, with larger household size, and those from Kalomo district in the Southern Province were observed to be significantly less likely to answer the quantity question, while contract farmers were significantly more likely to report their income than individual farmers.

Costs – Non-Labour and Labour

Non-labour costs

Farmers' non-labour costs are presented in Tables 5.1 and 5.2. Note that for the input costs, we include the principal variable costs such as tools, fertilizer, herbicide, pesticide and seeds, but not fixed cost such as land rental (where applicable – though importantly, land rental was not a large part of most farmers' production).

Table 5.1 – Non-labour costs in USD – Contract vs. Independent Farmer

	(1) Input		(2) Input Loan from Leaf Buyer		(3) Transport		(4) Levy	
	Per Acre	Per Kg	Per Acre	Per Kg	Per Acre	Per Kg	Per Acre	Per Kg
Contract	474.48	0.65	325.2	0.48	43.15	0.06	19.9	0.1
Independent	415.21	2.88	0	0	12.9	0.2	15.5	0.1
Total	467.42	1.28	325.2	0.48	28.49	0.1	18	0.09

Table 5.2 – Non-labour costs in USD – Virginia vs. Burley Tobacco Growers

	(1) Input		(2) Input Loans		(3) Transport		(4) Levy	
	Per Acre	Per Kg	Per Acre	Per Kg	Per Acre	Per Kg	Per Acre	Per Kg
Virginia	637.7	1.0	532.7	0.6	32.4	0.0	69.3	0.1
Burley	212.1	1.8	163.8	0.5	23.7	0.2	19.9	0.0
Total	467.42	1.3	389.5	0.6	28.5	0.1	50.5	0.1

The first set of columns in Table 5.1, (1) Input, suggests that contract farmers have higher input costs than their independent counterparts (~14.3%). In the second set of columns, (2) Input Loan from Leaf Buyer, we also see that most of the inputs are

"loaned" to the contract farmers (through their contracts). In this dynamic, typically, the farmers do not pay cash for these goods, but instead have the costs subtracted from the money owed to them at the time when they sell their tobacco leaves to the contracting leaf buyer. In Table 5.2, the results indicate that growing Virginia tobacco is significantly more input-intensive per acre than growing Burley tobacco.

Labour costs

Tobacco farming is typically labour-intensive particularly by small-holder farmers (Kibwage, Odondo and Momanyi, 2009). Accordingly, it is vital to evaluate the magnitude of farmers' efforts. Table 6 presents data on the average labour hours – combined total of all household members – needed to produce an acre and a kilogram of tobacco leaf. Note that the kilograms measure used in this table is the amount actually sold in the 2013/2014 season (not necessarily the amount produced, which is typically more because some tobacco is not sold for a variety of reasons, which can include poor quality). Labour hours from household members are slightly lower for contract farmers than individual farmers.

Table 6 – Labor Needs

	Labor Hours				
	Contract	**Individual**	**Virginia**	**Burley**	**Total**
Per Acre	1376.3	1444.6	1248.8	1497.5	1334.9
Per Kg	2.0	26.9	1.4	18.0	7.2

Based on 2013 monthly minimum wage data[1] for Zambia from the International Labor Office, and using Zambian and EIU exchange rates, the average labor cost in USD contributed by household members is presented in Table 7.

[1] Estimated Minimum Hourly Wage(USD) = (Minimum Monthly Wage/Working Hours per Month)*Exchange Rate=(700000/184)* 0.000175439=$0.667

Table 7 – Average Labor Cost in USD

	Household Members		Hired Labor	
	Per Acre	Per Kg	Per Acre	Per Kg
Contract	918.0	1.3	340.6	0.4
Individual	963.5	18.0	254.1	0.8
Virginia	833.0	0.9	313.5	0.4
Burley	998.8	12.0	285.3	0.9
Total	890.4	4.8	299.4	0.5

While contract farmers have higher labor costs for hired labor per acre than independent farmers, they have lower labor costs for hired labor per kilogram of tobacco sold.

Profit

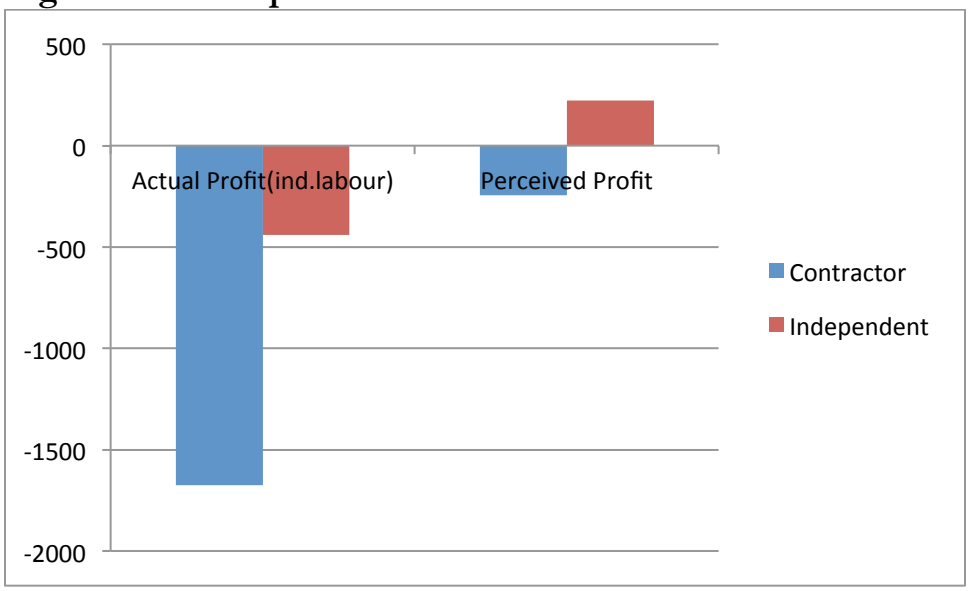
We took the cost data to the next logical step by calculating profits per acre, which is effectively, revenues from selling tobacco leaf minus the total (non-labour) input costs. As the red column on the far right of Figure 1 suggests, independent farmers on average made a small profit, roughly $200 USD per acre. This amount is considerably smaller than for most of the provinces on which Tembo and Sitko report recently (2013). For example, for Central, they reported Virginia mean gross margins (a reasonable equivalent of the measure used here) of $548/acre. Several other provinces were nearly as high, though Southern was less than $100/acre (2013, p. 29).

Importantly, note the blue bar on the right side of the graph, which indicates that contract farmers are actually losing money, contrasting markedly with Tembo and Sitko's findings. Note that they do not make a distinction between contract and independent farmers, but the findings here suggest a serious divergence from the data that they report, which draw from the Rural Agricultural Livelihoods survey. Possible explanations of the discrepancies include the volatile prices of tobacco, their use of a different sample of landowners that includes larger landowners making higher margins, and/or the input measure used here is more comprehensive.

In addition, considering the labor-intensive nature of tobacco growing, it is also useful to conceptualize profits when incorporating even a conservative estimate of the farmers' labour. When actual profit/acre is calculated to include personal and familial labor costs (outside labor is already included) using a very conservative valuation

outlined in footnote 3, neither contract farmers nor independent farmers are making "profits."

Figure 1 – Profit per Acre in USD



The results presented in Table 8 demonstrate a couple of important dynamic about buying and selling tobacco leaf. First, for contract farmers, they sometimes reports selling more than they harvested. Anecdotally, in neighboring countries, farmers reported selling tobacco under their contracts that they had purchased from neighbors. Second, many independent farmers reported in the survey selling significantly less than they harvested. While there was no question in the survey asking for an explanation of this dynamic, in neighbouring Malawi, independent farmers have complained that they are discriminated against in the marketplace (Chinele 2015).

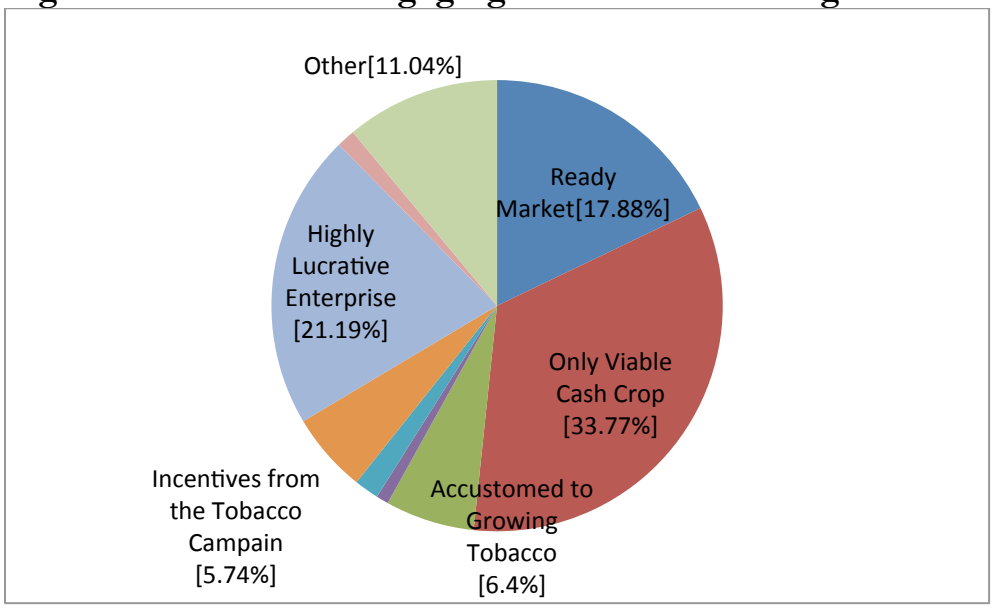
Table 8 – Tobacco Harvesting and Selling Discrepancies

	Harvested(kg)	**Sold(kg)**
Contractor	1511.7	1606.7
Independent	1111.3	761.7

Why Farmers Grow Tobacco

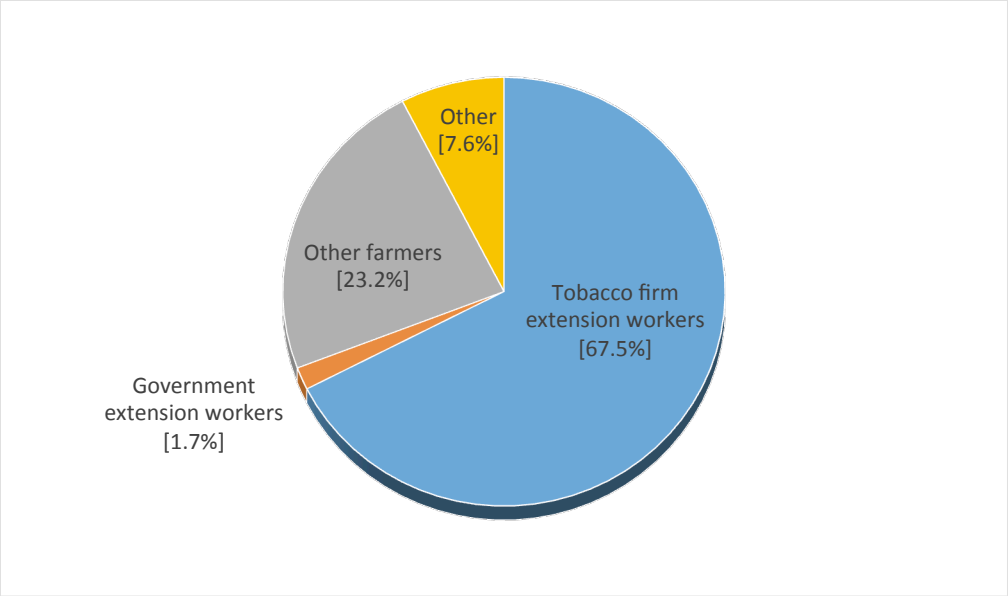
Particularly considering the findings highlighted in Figure 1 of a poor return on investment, one of the goals of the survey was to understand why farmers choose to grow tobacco, either instead of other crops and/or other economic activities, or in addition to them. As Figure 2 suggests, most farmers grow tobacco because they viewed it as the most viable crop (33.8%), some considered it as "being a lucrative enterprise" (21.2%), some attributed it to the ready market (17.9%)while others thought that they are accustomed to growing tobacco (6.4%).

Figure 2: Reasons for Engaging in Tobacco Farming



Similarly, since tobacco farming is relatively new to many parts of Zambia, the survey explored how tobacco farmers were recruited. As Figure 3 demonstrates, tobacco firms' extension workers recruit most of the farmers engaged in contract farming (67.5%). Note that these extension works do not work for the government, but instead, directly for the leaf-buying firms.

Figure 3: Recruitment into Tobacco Farming



Credit

Figures 4.1 and 4.2 demonstrate that most farmers are seeking credit to purchase inputs. While there are several other reasons that farmers seek credit including to pay labour, non-labour inputs are the most important reason. Also, the results in Table 4.2 suggest that particularly independent farmers are not able to access the credit that they need, which helps to explain the attraction to contract farming.

Figure 4.1 – Demand for Credit

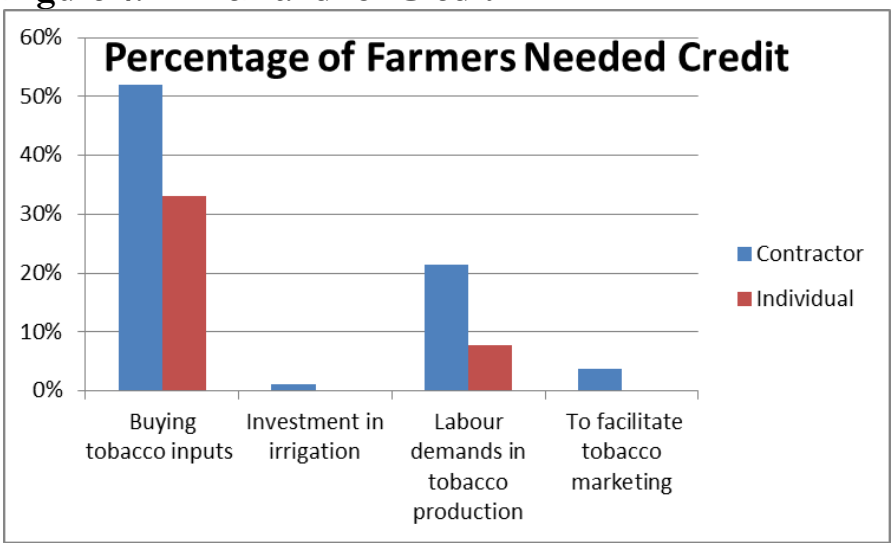
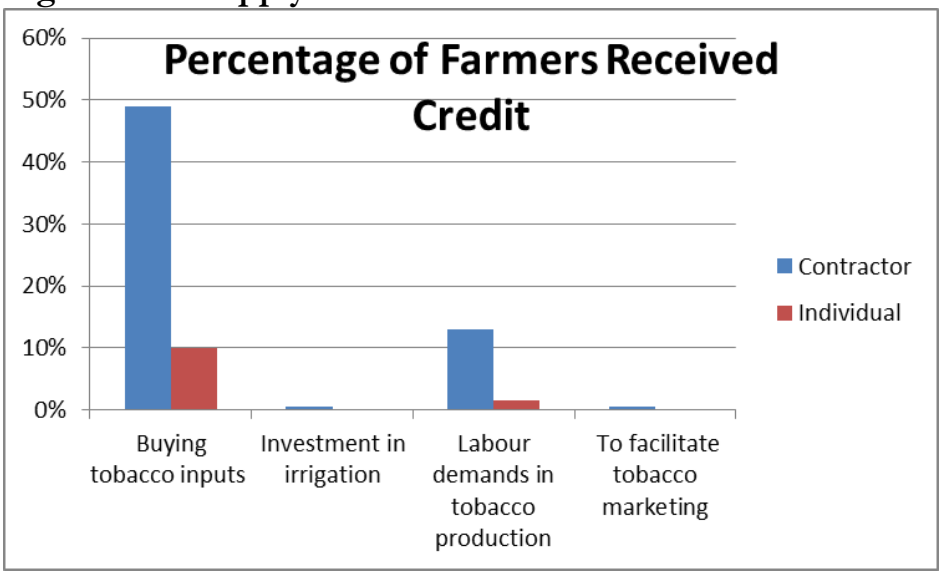
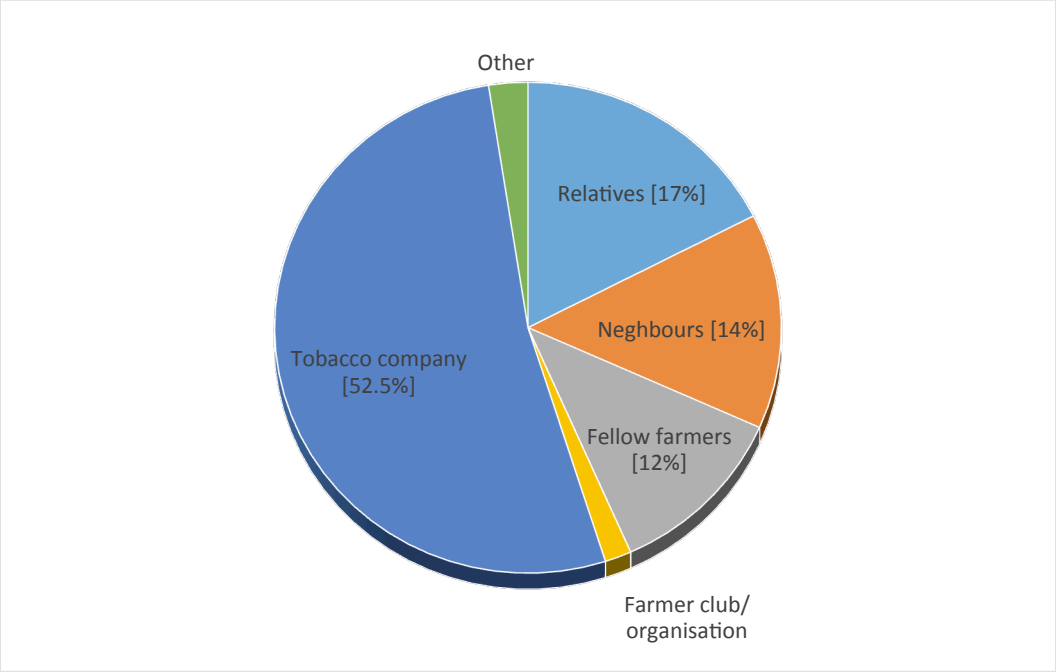


Figure 4.2 – Supply of Credit



The results in Figure 5 demonstrate that the most common lender to tobacco farmers is the leaf-buying companies. More than half of farmers report borrowing from the company with which they have a contract. Other common lenders included relatives (17%), neighbours (14%) and other farmers (12%). Notably, farmer clubs/organizations rarely lent money to tobacco farmers

Figure 5: Who Do Tobacco Farmers Owe



Of the 331 contract farmers surveyed, only 8.7 percent of respondents (29 farmers) reported selling tobacco outside of their contract. Only 1 respondent sold because they had an "urgent need for cash for critical inputs," including packaging materials and transportation. Six reported out-of-contract sales due to an "urgent need of cash for household use." If discovered, these contract violations could result in price and/or payment penalties for the farmer by the tobacco contractor. Three farmers reported out-of-contract sales due to no license to sell at auction floors. Finally, it is possible, perhaps even likely, that farmers under-report this dynamic in the survey fearing that they will be caught selling out of contract.

In general, many contract farmers reported that they had difficulty understanding their contracts. Roughly one third of contract farmers (107 out of 331) reported that they did not feel accurately informed about what was expected of them in the contract growing process.

With this observed common dissatisfaction with contract farming and its seemingly unlucrative nature, we sought to examine why many farmers continue to choose this route. Moreover, in terms of considering how to move tobacco farmers to alternative livelihoods as WHO FCTC Article 17 obligates the government, understanding why farmers might enter into a contract is likely to be important information as the strategies to incentivize switching might differ from independent farmers.

To examine this complex dynamic, we employed CHAID decision tree analysis to identify the most important explanatory variables. The complete results are in Appendix A, Part B. The five most important variables were the *Amount of tobacco harvested*, *Farming in Choma District*, *Household head age*, *Proportion of income from tobacco farming*, and *Input costs*. The analysis also identified specific sub-groups of farmers who are more likely to choose contract farming. For example, two discrete sub-groups of farmers had a virtual 100% probability of choosing contract farming. The characteristics of group 1 were: tobacco harvest > 710kg, living in Choma District, comparatively higher input costs and lower household income. The characteristics of the second group were: smaller harvest, less experience growing tobacco, low transportation costs, higher proportion of income from tobacco growing (>62%), self-farming (ie., limited hired labour) and high input costs. Such profiles should help proponents of alternative crops to understand who is likely to be contracting with a leaf buying company and consider the dynamic of that decision.

Satisfaction with the Selling Process

In order to understand better the overall perception of farmers, the survey examined tobacco farmers' satisfaction with the process of selling their crops. First, as illustrated in Table 9, most farmers were not satisfied with the classification of tobacco leaf by the leaf buyer, irrespective of whether they were on contract (76.8%) or independent (78.3). The farmers' dissatisfaction with the outcomes of the grading system might be reflective of a monopsonist market structure whereby lots of sellers compete to sell to few buyers. In such a situation, the single-buyer monopsonist, on account of their market power, strives to insure that the market price is lower than would have been the case were there many buyers (Lin, 2015).

Table 9: Farmer Satisfaction with Classification of Tobacco Leaf

Level of Satisfaction	Contract	Independent	Total
Satisfied	82 (23.2)	26 (21.7)	108 (22.8)
Not Satisfied	272 (76.8)	94 (78.3)	366 (77.2)
Total	354 (100.0)	120 (100.0)	474 (100.0)

As the findings presented in Table 10 suggest, in terms of the pricing, farmers were even less satisfied. The vast preponderance of both independent tobacco farmers (87.5%) and contract farmers (83.9%) reported dissatisfaction with the prices that they received from tobacco leaf buyers.

Table 10: Farmer Satisfaction with Pricing

Satisfaction	Contract	Independent	Total
Satisfied	58 (16.1)	16 (12.6)	74 (100.0)
Not Satisfied	303 (83.9)	112 (87.5)	415 (100.0)
Total	361 (100.0)	128 (100.0)	489 (100.0)

Food Security

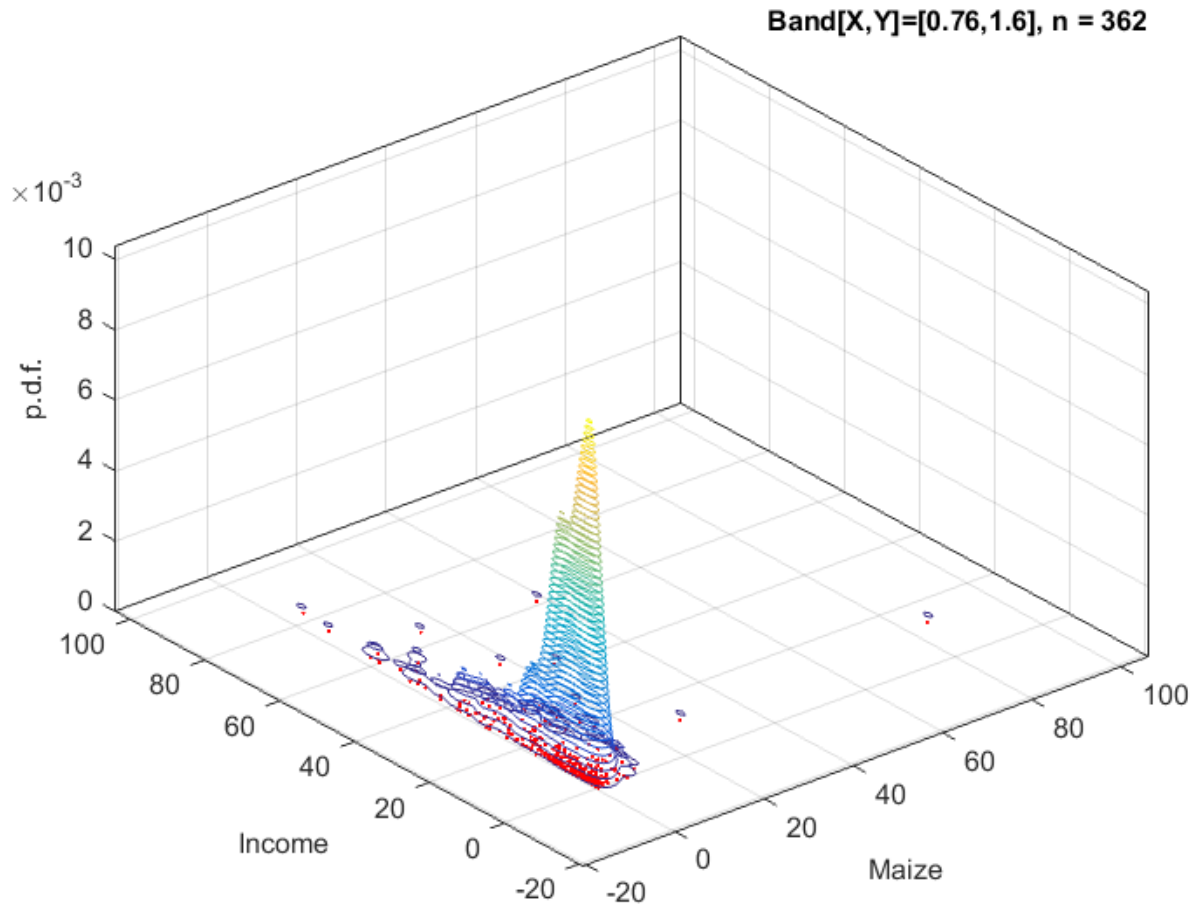
Some scholars have suggested that tobacco cultivation may be related – potentially negatively – to food security (Eriksen et al, 2015; Khisa, 2011). The results from the survey suggest that the dynamic is complex. Maize is the staple food in Zambia, and

unsurprisingly, 492 out of 500 respondents reported this fact, while 485 reported that they grow their own maize. 135 farmers reported that the maize that they grew on their own land was not enough to last their family for the year and they had to purchase maize to make up the difference. Of these farmers, most reported that the maize they grew lasted their household between seven and nine months. Notably, this is the average length of time that maize lasts most households in Zambia (Fink et al., 2014). On one hand, this dynamic may suggest the possibility of food insecurity. On the other hand, it might demonstrate participation in the agricultural marketplace in which farmers choose to grow other commodities to sell (in this case, probably mostly tobacco) and with the money earned, they purchase maize.

As Figure 6 below suggests, most farmers grow around the same amount of maize regardless of their income. In Appendix B, we show an additional figure that suggests that the overall size of a farmer's land also does not affect dramatically the amount of land they cultivate with maize. In other words, farmers with larger incomes and/or land plots were not necessarily growing more maize, but instead were allocating proportionally more land to the cash crop, tobacco leaf. We speculate that many farmers grow some maize for overall food security in case their cash crop does poorly or fails, but appear to purposely not grow all of the maize necessary to feed the household for 12 months and instead allocate land to the cash crop. These results are important, but preliminary, and more research on both crop selection decisions and household calorie intake is necessary to explore this dynamic better (for example, how much does calorie intake vary with the amount of land owned/cultivated and/or income).

In a further effort to understand the relationship between tobacco growing and food security, we employed a CHAID tree model. From a policy perspective, this information will help decision-makers to understand who is more or less likely to be food secure. As a dependent variable, we used the results from the survey question, "Does the food (maize grown by farmer) last you the whole year." The five most significant variables were *Hours of Labor Used per Acre*, *Age of the Household Head*, *Total Household Income*, *Amount of Tobacco Harvested*, and *Tobacco Price per Kilogram*. In Appendix A, Part C, we have included the probabilities of a series of discrete groups that are more and less likely to be food secure. For example, age and experience appear to matter because older farmers (>36) who work on labour-intensive farms (>1027 hours/acre) with low tobacco yields and low overall incomes actually have a higher probability of being secure in terms of the amount of maize grown to feed their families.

Figure 6 – Total household income against actual maize grown (bivariate probability density function)



Personal Economic Situation

Beyond farmers' incomes – both tobacco and non-tobacco – the survey also sought to evaluate the general economic situation of the farmers. Owning agricultural assets such as cattle (51.7%), an ox-plough (46.1%) and wagon (34.6%) are critical to increased productivity because these assets either can generate income or can directly help in farming, and are presented in Table 11.

Table 11 – Agricultural Assets

Item	Number of Farmers	Percent
Cattle	257	51.7
Goats	211	42.5
Pigs	113	22.7
Sheep	29	5.8
Chickens	402	80.9
Ox-plough	229	46.1
Tractor	18	3.6
Wagon	172	34.6
Jack	47	9.5

Patterns of Land Ownership

The median size of the land owned by both independent and contract tobacco farmers appears to be the same at 10 acres, as illustrated in Table 12 below. Notably, for Zambia as a whole, the average landholding per small to medium scale farming household is about 4 acres (Tembo and Sitko, 2013), which suggests that small-holder tobacco farmers tend to have more land on average than many other types of farmers.

Table 12: Total Land Owned (Acres)

	Independent Farmer	Contract Farmer
Median	10.0	10.0
Minimum	0.5	1.0
Maximum	75.0	80.0

The patterns of land use reported in Table 13 compare quite closely with those from other surveys. For example, using data from a nationally representative survey, Tembo

and Sitko (2013) found that the average tobacco farmer utilized about 1.8 acres of land for tobacco cultivation. For other crops, land utilization sizes were as follows: 2.5 acres for maize, 2.8 acres for cotton and 1 acre for coffee (ibid.).

Table 13: Land Under Cultivation

	Independent Farmer		**Contract Farmer**	
	Total cultivation	**Tobacco Cultivation**	**Total cultivation**	**Tobacco Cultivation**
Median	4.5	1.0	5.0	1.5
Minimum	0.3	0.3	0.5	0.5
Maximum	42.5	20.0	80.0	12.5

The survey examined closely the type of land ownership of tobacco farmers, which is presented in Table 14. Most respondents identified their land as freehold/inherited/ purchased at 65.8%.

Table 14: Legal Entitlement of Land

Category	**n**	**Percent**
Freehold /Inherited/ Purchased	237	65.8
Leasehold	4	1.1
Communal	56	15.6
Owned with title deed	21	5.8
Owned with allotment letter	6	1.7
Settlement scheme by government	19	5.3
Other	17	4.7
Total	360	100.0

Some farmers also rented additional land. A total of 43.2% (216 out of 500) of farmers reported renting land to cultivate. On average these renters rented 0.65 acres, and typically this added 9.9% extra acreage to what they owned. Contract farmers on average rent 0.69 acres and independent farmers on average rent 0.59 acres. Older respondents and independent farmers were significantly less likely to rent.

Child Labour

There has been significant regional and international concern about children working in tobacco growing, particularly around missing school (Otanez et al, 2006) and also health issues around green tobacco sickness (McBride et al, 1998). As the results in Table 15 suggest, nearly a quarter of respondents (22.5%) reported that children were engaged in tobacco production activities on their farms, with harvesting and weeding reported as the two most common activities. Very few farmers reported that children were working during school hours, though self-reporting is not likely completely reliable since young children are supposed to attend school during the mandatory hours and there is stigma attached to keeping young children from school.

Table 15 – Children working in tobacco cultivation

Tasks Related to Tobacco Cultivation	# total cases – help of children	# total cases – during school time
Nursery Preparation	47	6
Nursery Sowing	47	3
Fertiliser Application-Nursery	29	5
Chemical Application	12	2
Watering of Nursery	58	5
Land Preparation	52	5
Planting	58	3
Fertilizer application1	50	11
Weeding	64	7
Drying shed preparation	21	3
Fertilizer application 2	36	6
Banding	46	2
Chemical application	11	1
Harvesting	69	6
Drying/curing	21	1
Grading	26	6
Baling/Packaging	32	2

Future of Growing

At the end of the survey, the respondents were asked to consider the future of growing tobacco. The results suggest that a large proportion of tobacco farmers – 60.1% – are considering a switch from tobacco to another crop. Similarly, 51.2% of farmers in the survey reported that they do not envision themselves growing tobacco in the next five years.

The policymakers charged with helping tobacco farmers to find alternative livelihoods need information on how to best approach this challenging set of tasks. To assist this process, it would be helpful to know which farmers are most seriously considering switching as they may be the proverbial "low-hanging fruit" to target first with good alternative livelihood options and policies. Accordingly, we used multivariate analysis to identify which discrete sub-groups of farmers would be most likely to switch from tobacco to other crops. We employed both a decision tree method and linear regression to examine this question. The complete results are available in Appendix A (Part A), but we will summarize some key findings here. First, the CHAID tree analysis revealed the most important variables to be: *Growing Virginia*, *Living in Choma*, *House Head Age*, *Wage Paid to Hired Labor*, and *Experience of Growing Tobacco*. The analysis also identified several discrete groups that demonstrate particularly high probabilities of being open to switching (>95%). For example: Virginia tobacco growers, who live in Choma District, are relatively new to tobacco farming (< 3.5 years), who pay little or nothing to transport their tobacco to market, and have high input costs (>1838) are highly likely to consider alternatives to cultivating tobacco leaf. Similarly, a subset similar to above but with lower input costs and more land (>4.25 acres) are also highly likely to switch. Similarly, the analysis identifies the groups much less likely to switch. When deciding how to allocate resources to alternative livelihoods, knowing who will switch and will resist is highly valuable.

CONCLUSION

The results of this research demonstrate that tobacco farming is not a lucrative economic livelihood for most farmers. It appears to be particularly difficult for contract farmers – now the vast majority in Zambia – who enter into legal agreements that frequently may doom them to a cycle of perpetual debt and difficulty moving to a different pursuit that is healthier and more prosperous (agricultural or otherwise). Ironically, one of the reasons that farmers choose to contract is the perceived **availability of credit** (i.e., not needing cash to pay for inputs at the beginning of the season) and the certainty of being able to sell even, apparently, if it turns out that the terms of the sale are very poor. Of course, before signing the contract, there is no guarantee of even a minimum price. For most independent farmers, they are scratching out a living that is rarely better than other crops, often at the expense of their health and land since tobacco growing can cause green tobacco sickness (Arcury and Quandt, 2006) and the cultivation of tobacco being very fertilizer-, pesticide- and herbicide-intensive puts enormous strain on the land and surrounding environment (Eriksen et al, 2015).

In recent years, Zambia's government – like many others – has appeared to believe that tobacco is a viable economic development strategy. It has even provided incentives for tobacco manufacturing and processing (Lencucha et al, 2015). But not only does tobacco bring enormous harm to human health in myriad ways, **tobacco farming appears to be stunting, not helping, economic development in the Zambian context**. In the coming years, Zambia's government would be wise to reconsider the recent support for tobacco production and instead seek viable livelihoods that would help industrious Zambians. Part of this strategy must include better access to credit and helping to develop improved markets for other types of agricultural (and non-agricultural) products. The results of this research unequivocally show that **tobacco farmers demonstrate enormous resolve to work their land**, often for almost unfathomable numbers of hours – imagine the rewards for both farmers and the Zambian economy more broadly if these Herculean efforts were put to much healthier and more prosperous economic pursuits.

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Appendix A – Results of multivariate analyses

In order to make the multivariate analyses as intuitive as possible to readers of this report, we employed Chi-squared Automatic Interaction Detection (CHAID), a type of decision tree technique that is based upon adjusted significance testing. It is visual in nature by dividing observations into subgroups in order to identify the most affected subgroups. Each subgroup is a combination of branches that reads from left to right. An example of how to read a decision tree is included in Part A, "Future of Tobacco Farming." Readers can use the same method to interpret Part B, "Farmers' decisions to contract" and Part C, "Food Security." Finally, linear regression models and other related techniques were employed for continuous dependent variables to check robustness of the findings and we include the general findings in each sub-section below.

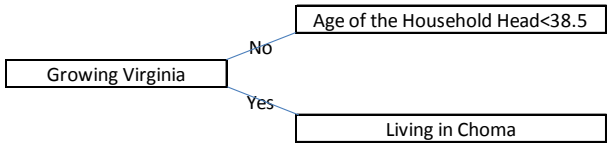
Part A – Future of Tobacco Farming

The CHAID Tree model is used to analyze the future of growing tobacco, utilizing the results from the survey question "Have you considered switching from tobacco production?" as the dependent variable. The 23 subgroups and the possibility for each subgroup to switch are presented in Chart 1, Chart 2 and Table 1. Important explanatory variables are listed on each node in Chart A-1. The most important explanatory variables are *Growing Virginia*, *Living in Choma*, *House Head Age*, *Wage Paid to Hired Labor*, and *Experience of Growing Tobacco*.

How to Read the Tree

For example, to find a particular survey response's predicted probability of switching, one starts from the first node on the very left in Chart 1.

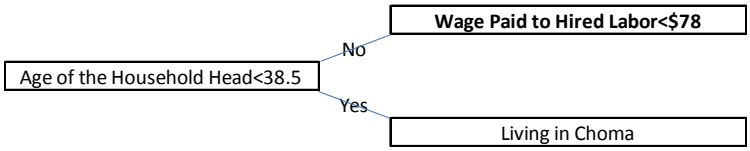
Node 1



Does the farmer grow Virginia or another type of tobacco? If the farmer does not grow Virginia, one moves to the upper right to the second node to decide if the household head is younger than 38.5 years old. If the farmer grows Virginia, one moves downward to decide if the farmer lives in Choma or other districts in Zambia.

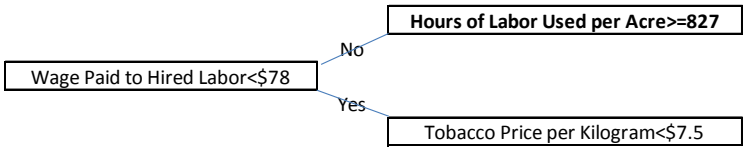
Suppose we observe a 40-year-old farmer growing Burley tobacco, paying 500 dollars for hired labor in the tobacco farming season, and his or her family members working 1000 hours on tobacco farming for the season. We start with node 1 in Chart 1 and moves toward the upper right to Node 2 because the farmer grows Burley instead of Virginia.

Node 2



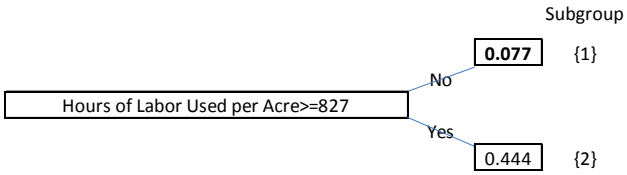
The farmer is 40-years-old, which is more than 38.5, so we move toward upper right to the branch with Node 3 to see if the farmer is paying $78 or less for the hired labor for the tobacco farming season.

Node 3



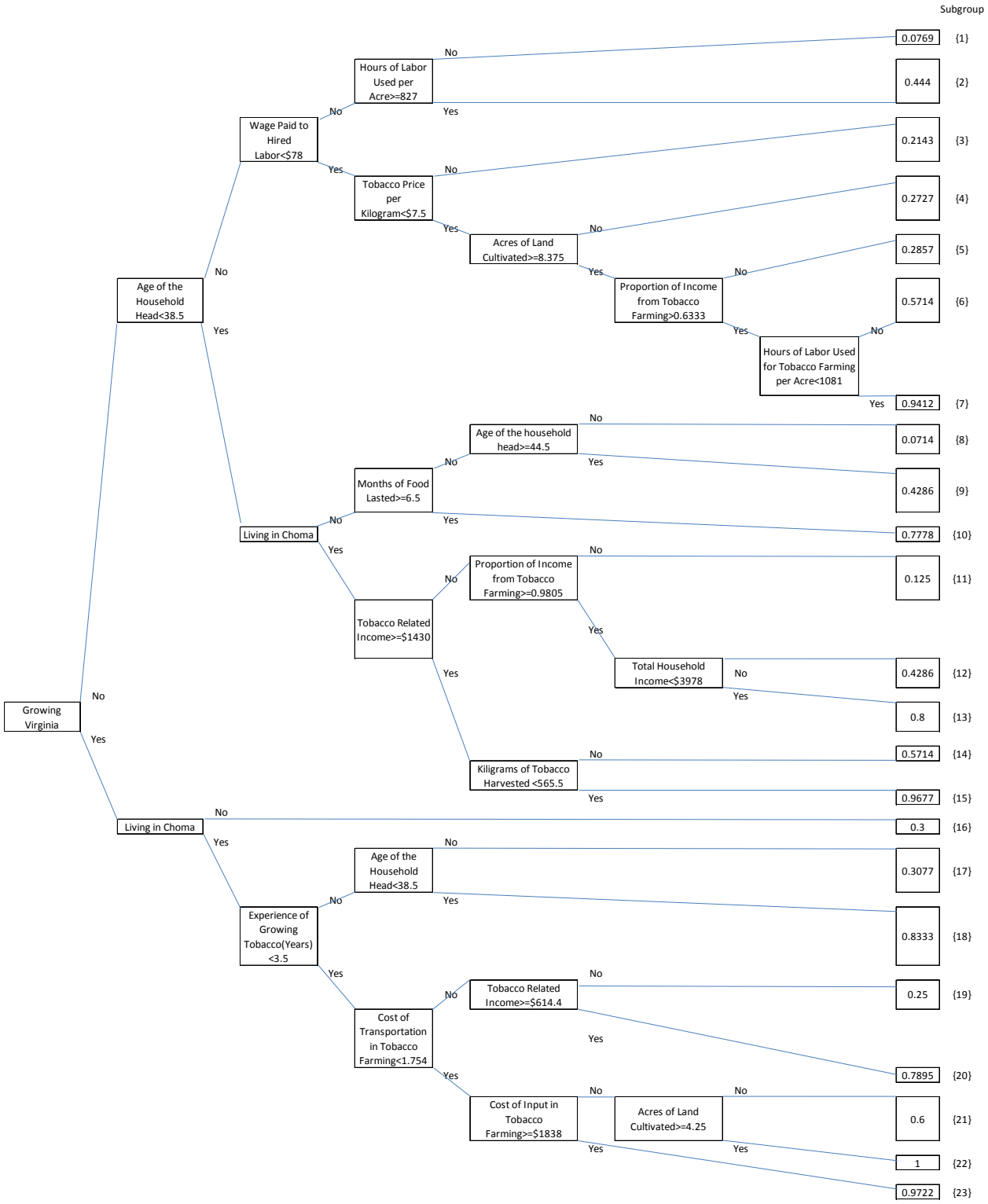
The farmer is paying 500 dollars for hired labor to grow the tobacco leaf, so we move toward the upper right again to the branch with Node 4 to see if the hours of labor used per acre for tobacco farming is greater or equal to 827.

Node 4



The farmer's family members work 1000 hours on tobacco farming for the season, so we move toward the upper right again and categorize this farmer into subgroup 1. In this sub-group, we observe the probability that this farmer might consider switching from tobacco production to be 0.077. In other words, farmers with this general profile are highly unlikely to consider alternative livelihoods.

Chart A-1


Subgroup
Growing Virginia
No
Yes
Age of the Household Head<38.5
No
Yes
Wage Paid to Hired Labor<$78
No
Yes
Hours of Labor Used per Acre>=827
No
Yes
0.0769
{1}
0.444
{2}
Tobacco Price per Kilogram<$7.5
No
Yes
0.2143
{3}
Acres of Land Cultivated>=8.375
No
Yes
0.2727
{4}
Proportion of Income from Tobacco Farming>0.6333
No
Yes
0.2857
{5}
Hours of Labor Used for Tobacco Farming per Acre<1081
No
Yes
0.5714
{6}
0.9412
{7}
Living in Choma
No
Yes
Months of Food Lasted>=6.5
No
Yes
Age of the household head>=44.5
No
Yes
0.0714
{8}
0.4286
{9}
0.7778
{10}
Tobacco Related Income>=$1430
No
Yes
Proportion of Income from Tobacco Farming>=0.9805
No
Yes
0.125
{11}
Total Household Income<$3978
No
Yes
0.4286
{12}
0.8
{13}
Kiligrams of Tobacco Harvested <565.5
No
Yes
0.5714
{14}
0.9677
{15}
Living in Choma
No
Yes
0.3
{16}
Experience of Growing Tobacco(Years) <3.5
No
Yes
Age of the Household Head<38.5
No
Yes
0.3077
{17}
0.8333
{18}
Cost of Transportation in Tobacco Farming<1.754
No
Yes
Tobacco Related Income>=$614.4
No
Yes
0.25
{19}
0.7895
{20}
Cost of Input in Tobacco Farming>=$1838
No
Yes
Acres of Land Cultivated>=4.25
No
Yes
0.6
{21}
1
{22}
0.9722
{23}

Results

The probability of the switching behavior for each discrete subgroup is presented in Chart A-2 and Table A-1. The sub-group most likely to switch is subgroup #22, who are Virginia growers living in Choma, with less than 3.5 years of experience of growing, with low or no transportation costs to get their product to market, with input costs of less than $1,838 (USD), and having more than 4.25 acres of cultivated land. Their probability of seriously considering switching is 100%. However, only 2.3% of total observations in the sample fall into this subgroup, which can be seen in Table A-1, which shows both the possibility of switching behavior among subgroups and the weight distribution. The farmers with the lowest probability of switching are in subgroup #8 at 7%.

Chart A-2 Probability Rank for Switching

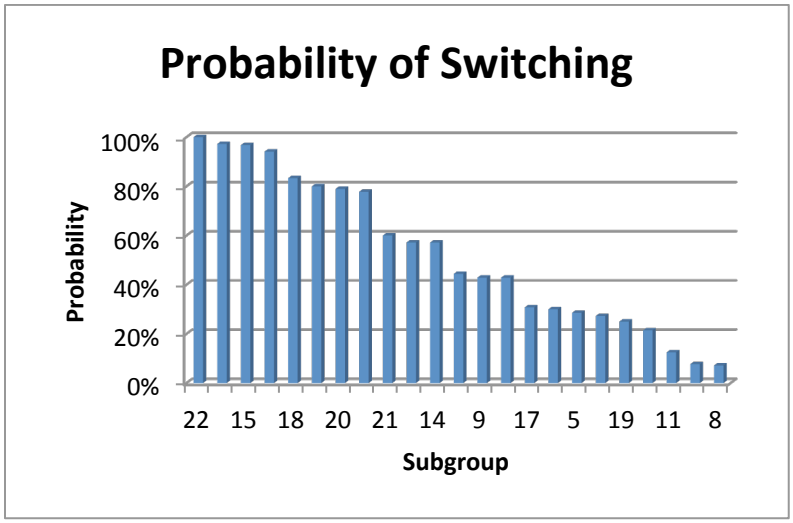


Table A-1 Probability and Weight for Switching

Subgroup	Probability	Weight
1	0.07692	8%
2	0.444	6%
3	0.2143	4%
4	0.2727	3%
5	0.2857	2%
6	0.5714	4%
7	0.9412	5%
8	0.07143	4%
9	0.4286	2%
10	0.7778	3%
11	0.125	2%
12	0.4286	2%
13	0.8	5%
14	0.5714	2%
15	0.9677	10%
16	0.3	3%
17	0.3077	4%
18	0.8333	4%
19	0.25	2%
20	0.7895	6%
21	0.6	5%
22	1	2%
23	0.9722	11%

Robustness

To check the robustness of the CHAID results, we employed complementary techniques, including stepwise logistic regression, random forest and Multivariate Adaptive Regression Splines (MARS) methods. The different methods generated results with similar explanatory variables. Below, we highlight the main statistically significant findings with the direction of the relationship parenthetically for the logistic regression and MARS results.

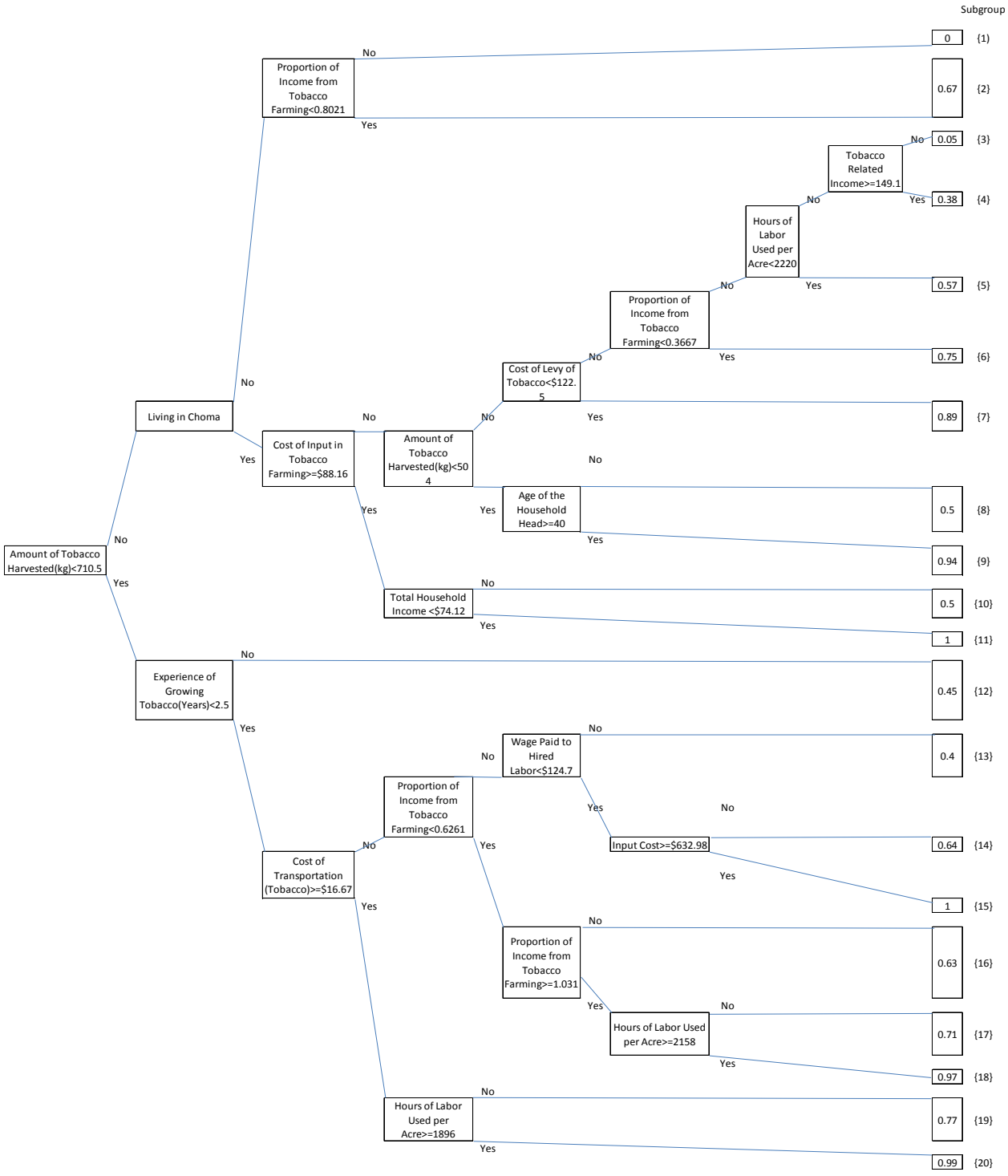
Logistic regression: House head age (-), size of land cultivated (-), living in Choma (+) and living in Kalomo (+).

Random forest: The most significant variables are Tobacco Related Income, Experience of growing tobacco in years, Living in Choma, Tobacco Price per Kilogram, Cost of Transportation.

MARS: Living in Choma (-), living in Kalomo (-), House Head Age below 26 (-), House Head Age 27 to 33(-), House Head Age 34(+), and Tobacco Related Income between $53 to $174 (-).

Part B – Why farmers choose contract farming

A CHAID tree model was employed to analyze the variables contributing to the decision of a farmer to contract with a leaf-buying company. The variable *Contract farmer* was used as the dependent variable. The 20 subgroups and the probabilities for each subgroup to choose contract farming is presented in Chart B-3, Chart B-4 and Table B-2. Important explanatory variables are listed on each node in Chart B-3. The five most important variables according to the analysis are the *Amount of tobacco harvested*, *Farming in Choma District*, *House head age*, *Proportion of income from tobacco farming*, and *Input costs*.


Subgroup
Amount of Tobacco Harvested(kg)<710.5
No
Yes
Living in Choma
No
Yes
Experience of Growing Tobacco(Years)<2.5
No
Yes
Proportion of Income from Tobacco Farming<0.8021
No
Yes
Cost of Input in Tobacco Farming>=$88.16
No
Yes
Cost of Transportation (Tobacco)>=$16.67
No
Yes
Amount of Tobacco Harvested(kg)<504
No
Yes
Total Household Income <$74.12
No
Yes
Cost of Levy of Tobacco<$122.5
No
Yes
Age of the Household Head>=40
No
Yes
Proportion of Income from Tobacco Farming<0.6261
No
Yes
Hours of Labor Used per Acre>=1896
No
Yes
Wage Paid to Hired Labor<$124.7
No
Yes
Proportion of Income from Tobacco Farming>=1.031
No
Yes
Input Cost>=$632.98
No
Yes
Hours of Labor Used per Acre>=2158
No
Yes
Proportion of Income from Tobacco Farming<0.3667
No
Yes
Hours of Labor Used per Acre<2220
No
Yes
Tobacco Related Income>=149.1
No
Yes
0 {1}
0.67 {2}
0.05 {3}
0.38 {4}
0.57 {5}
0.75 {6}
0.89 {7}
0.5 {8}
0.94 {9}
0.5 {10}
1 {11}
0.45 {12}
0.4 {13}
0.64 {14}
1 {15}
0.63 {16}
0.71 {17}
0.97 {18}
0.77 {19}
0.99 {20}

Results

The probabilities of choosing contract farming for each subgroup are presented in Chart B-4 and Table B-2. Subgroups #11 and #15 have the highest probability of choosing contract farming over independent farming, at 100% (6% and 3% of total observations in the sample fall into the two subgroups respectively). Subgroup #1 demonstrates the lowest probability of choosing contract farming.

Chart B-4 – Probability Rank of Choosing Contract Farming

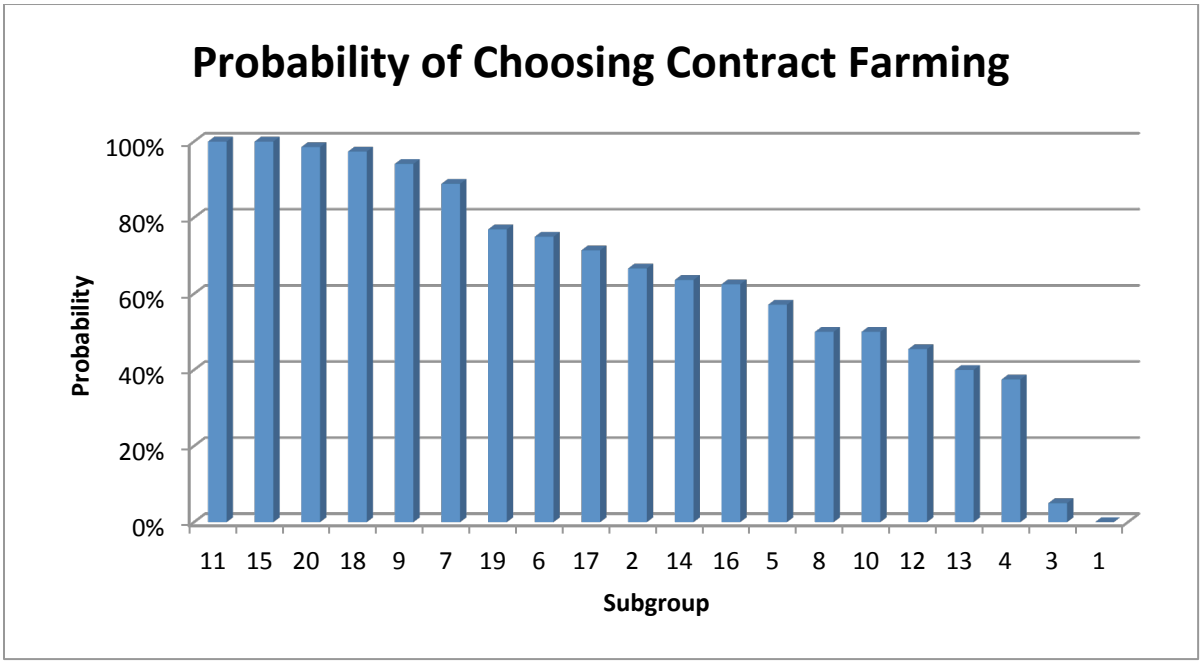


Table B-2 – Probability and Weight for Being Contract Farmer

Subgroup	Probability	Weight
1	0	7%
2	0.6667	3%
3	0.05	6%
4	0.375	3%
5	0.5714	2%
6	0.75	3%
7	0.8889	3%
8	0.5	3%
9	0.9412	5%

10	0.5	3%
11	1	6%
12	0.4545	4%
13	0.4	3%
14	0.6364	4%
15	1	3%
16	0.625	3%
17	0.7143	2%
18	0.9737	12%
19	0.7692	4%
20	0.9855	22%

Robustness

We employed stepwise logistic regression, random forest and Multivariate Adaptive Regression Splines (MARS) methods to check the robustness of the tree analysis, and the different methods generated similar results to the CHAID.

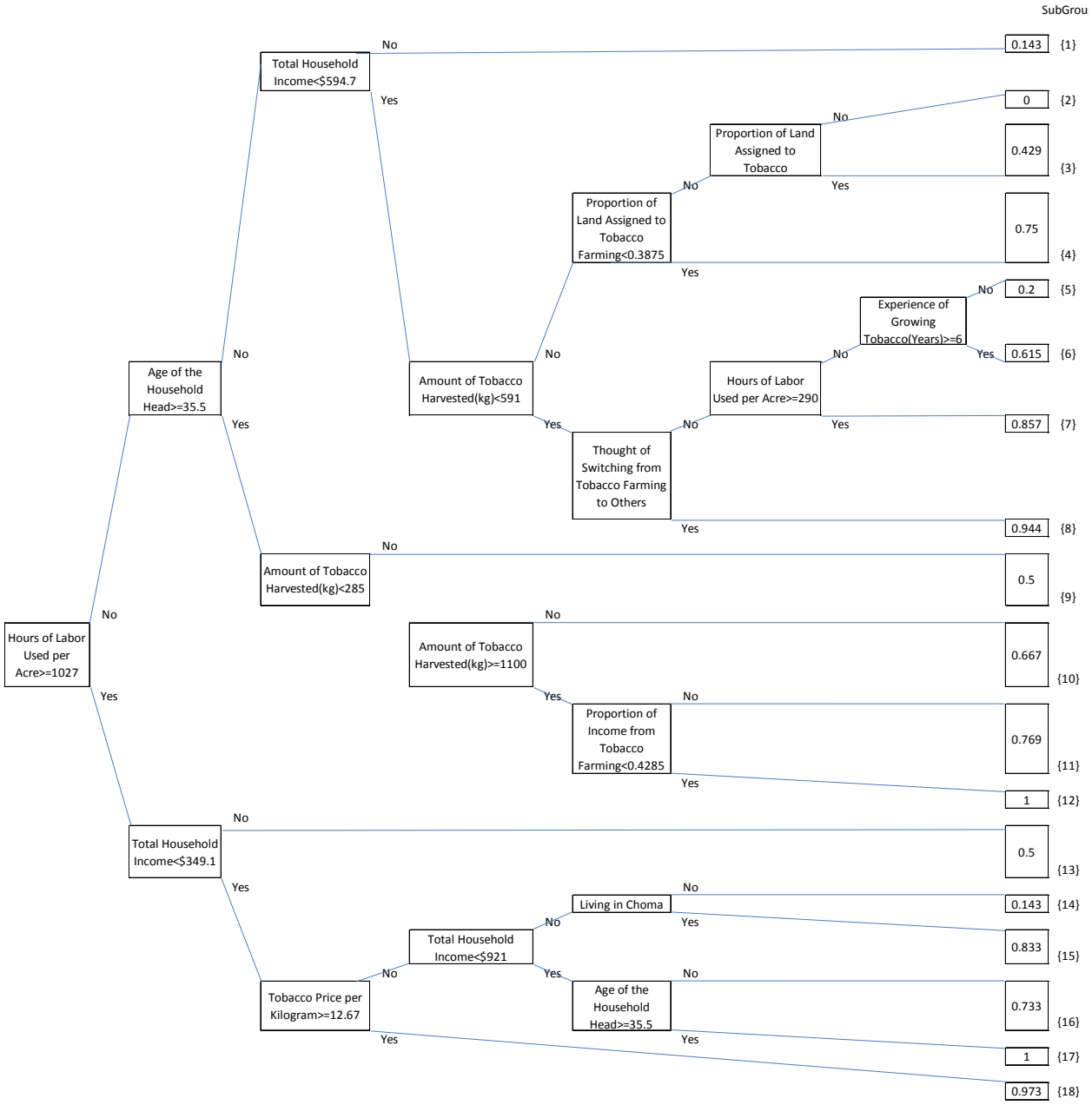
Logistic regression: Tobacco Related Income (+), living in Choma (-), Proportion of Land Assigned to Tobacco Farming (+), and Hours of Labor Used per Acre (+).

Random forest: Amount of Tobacco Harvested, Experience of Growing Tobacco(Years), Cost of Input in Tobacco Farming, Acres of Tobacco Planted, living in Choma and Hours of Labor Used per Acre

MARS: Amount of Tobacco Harvested between 153kg to 280kg(+), Amount of Tobacco Harvested between 280kg to 1200kg(-),Tobacco Related Income from 877 to 1053 dollars(+),Tobacco Related Income from $1054 to $1491(-), Tobacco Related Income from $1492 to $1579(+),Tobacco Related Income above $1579(-). Proportion of Land Assigned to Tobacco Farming from 17% to 19%(+), Proportion of Land Assigned to Tobacco Farming above 19% (-), Hours of Labor Used per Acre from 328 to 2254(-),Hours of Labor Used per Acre from 2254 to 2403(-)Input Cost from $41 to $169(-) and Transportation Cost above $156(-).

Part C – Food Security

A CHAID Tree model was employed to analyze the variables that may contribute to tobacco farmers' food security. The results from the survey question, "Does the food (maize) that you grow last you the whole year" was used as the dependent variable. The 18 subgroups and the possibility for each subgroup to have food security are presented in Chart C-5, Chart C-6 and Table C-3. The key significant explanatory variables are listed on each node in Chart 5. The five most significant variables are *Hours of Labor Used per Acre*, *Age of the Household Head*, *Total Household Income*, *Amount of Tobacco Harvested*, and *Tobacco Price per Kilogram.*


SubGrou
Hours of Labor Used per Acre>=1027
No
Yes
Age of the Household Head>=35.5
No
Yes
Total Household Income<$594.7
No
Yes
0.143
{1}
Amount of Tobacco Harvested(kg)<591
No
Yes
Proportion of Land Assigned to Tobacco Farming<0.3875
No
Yes
Proportion of Land Assigned to Tobacco
No
Yes
0
{2}
0.429
{3}
0.75
{4}
Thought of Switching from Tobacco Farming to Others
No
Yes
Hours of Labor Used per Acre>=290
No
Yes
Experience of Growing Tobacco(Years)>=6
No
Yes
0.2
{5}
0.615
{6}
0.857
{7}
0.944
{8}
Amount of Tobacco Harvested(kg)<285
No
0.5
{9}
Amount of Tobacco Harvested(kg)>=1100
No
Yes
0.667
{10}
Proportion of Income from Tobacco Farming<0.4285
No
Yes
0.769
{11}
1
{12}
Total Household Income<$349.1
No
Yes
0.5
{13}
Tobacco Price per Kilogram>=12.67
No
Yes
Total Household Income<$921
No
Yes
Living in Choma
No
Yes
0.143
{14}
0.833
{15}
Age of the Household Head>=35.5
No
Yes
0.733
{16}
1
{17}
0.973
{18}

Results

The probability of the switching behavior for each subgroup can be seen in Chart 6 and Table 3.It can be seen that the most possible group to have food security are subgroup 12 and 17. They have a probability of 100% being contract farmer. 8% and 9% of total observations in the sample fall into the two subgroups respectively, which can be seen in table 3. The least possible group for being contract farmer is subgroup 2.

Chart C-6 Probability Rank for Food Security

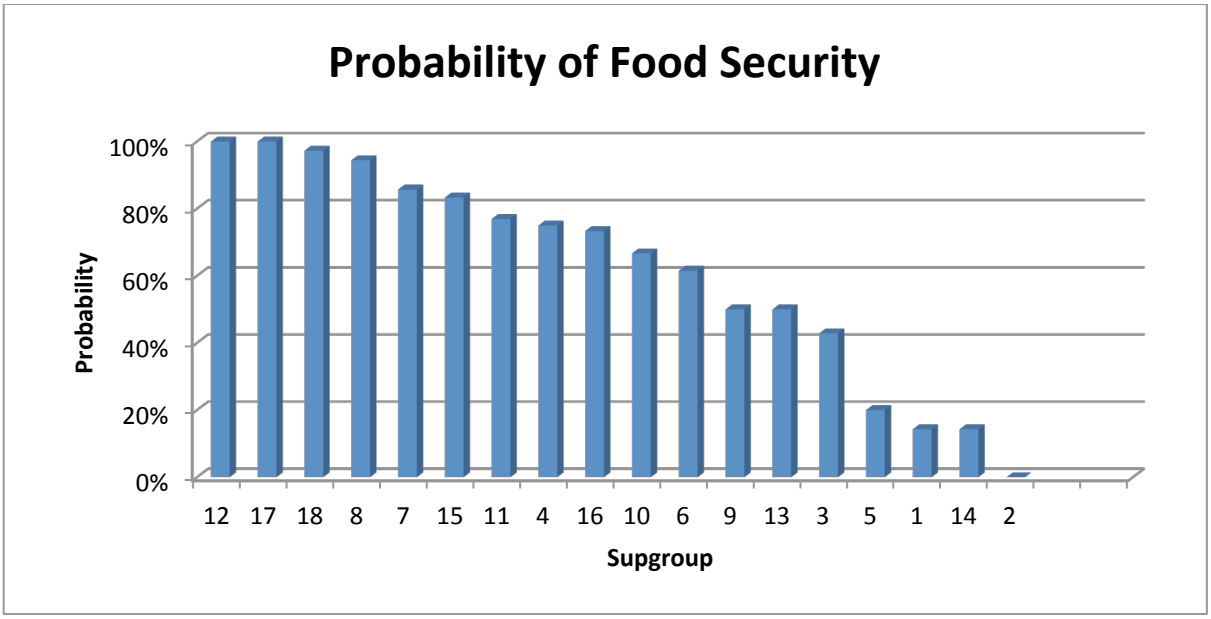


Table 3 shows the possibility of being food secured among subgroups and the weight distribution.

Table C-3 Probability and Weight for Food Security

Subgroup	Probability	Weight
1	0.1429	4%
2	0	4%
3	0.4286	2%
4	0.75	2%
5	0.2	5%
6	0.6154	4%
7	0.8571	4%
8	0.9444	6%
9	0.5	3%

10	0.6667	6%
11	0.7692	4%
12	1	8%
13	0.5	2%
14	0.1429	2%
15	0.8333	6%
16	0.7333	5%
17	1	9%
18	0.973	23%

Robustness

Random forest and Multivariate Adaptive Regression Splines (MARS) methods were employed to check the robustness of the tree analysis, and both identified similar explanatory variables.

Random forest: Hours of Labor Used per Acre, Age of the Household Head, Amount of Tobacco Harvested, Cost of Input in Tobacco Farming, Tobacco Related Income and Acres of Tobacco Planted

MARS: Age of the Household Head from 29 to 38(-), Age of the Household Head more than 38(+), Total Household Income from $526 to $618 (+),Total Household Income from $681 to $867 (-), Total Household Income is $867 and above(+), Amount of Tobacco Harvested (-), Acres of Tobacco Planted from 0.5 to 3 acres (-),Acres of Tobacco Planted are 3 acres and above (+), Hours of Labor Used per Acre from 2403 to 3468 (-),Hours of Labor Used per Acre above 3468 (+).

Appendix B – Land Size vs. Maize Production (probability density function)