Tobacco substitutability and its effect on producer revenue and foreign exchange earnings under smallholder agriculture in Malawi

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Abstract

This paper analyses the effect of tobacco substitution on the welfare of smallholder farmers in Malawi and provides policy options within the agricultural sector for diversifying the Malawi tobacco-based economy. An ex ante biophysical economic modelling approach was used to analyse changes in consumer welfare, producer revenue and foreign exchange (forex) earnings under assumptions of continued and curtailed tobacco production in Malawi. When tobacco was curtailed, sugarcane and groundnuts offered the best substitutes, contributing over 60% to both producer revenue and forex earnings. The curtailing of tobacco, however, led to a consumer welfare loss of 3%, producer revenue loss of 44% and forex earnings loss of 73%. Forex earnings losses were averted, however, by increasing export markets of certain crops, e.g. sugarcane by a factor of 0.9. In view of tobacco market instabilities and mounting pressure to curtail tobacco production on the global level, these study findings may guide policy decisions on optimal tobacco diversification options for Malawi.

Key words: tobacco substitution; welfare losses; Malawi

1. Introduction

Tobacco is considered the "green gold" of Malawi (Orr 2000; Yasuharu & LaStarria-Cornhiel 2015; Negri & Porto 2016). Malawi is also the most tobacco-dependent country in the world (Prowse 2013; Prowse & Moyer-Lee 2015). Since the 1960s, tobacco has consistently contributed between 60% and 70% of the total forex earnings (Government of Malawi [GoM] 2011; Prowse & Moyer-Lee 2015), 13% of the GDP, 23% of the government's tax base (Tchale & Keyser 2010) and 40% of total employment (Tsonga & Mataya 2001). Tobacco has also been estimated to provide the largest cash flows in the rural areas of Malawi (Prowse 2013). Many authors (Ng'ong'ola 1996; Orr 2000; Prowse 2013) have reported that tobacco revenues have multiplier effects on the production of other crops, e.g. by providing income for inputs such as seeds and fertilisers for the production of other crops.

However, arguments against tobacco production are emerging and have resulted in a worldwide anti-tobacco campaign. Such campaigns are championed by international organisations such as the World Bank and the World Health Organization through the Framework Convention on Tobacco Control (Tsonga & Mataya 2001; Keyser 2007). Those against tobacco production argue that tobacco is detrimental to both human health (Stephen 2016) and the environment (Lecours *et al*. 2012). For instance, globally, tobacco is known as a pesticide intensive crop, resulting in environmental pollution (McDaniel *et al*. 2005), and is also considered to be the cause of deforestation due to crop area expansion and firewood gathering for curing (Markowitz 2014; Novotny & Slaughter 2014). Tobacco is also described as an input-expensive crop, which leaves the majority of smallholder farmers in debt, as most farmers lack the capital to purchase the inputs on their own (Pryor 1990; WHO 2016). Additionally, working conditions on tobacco farms have also come under heavy criticism, especially regarding the utilisation of child labour (Otanez *et al*. 2006).

In contrast, there also are arguments in favour of tobacco production. First, those in favour of tobacco production argue that, following the Montreal Protocol, which banned the use of methyl bromide, the use of pesticides in tobacco production has been reduced or phased out altogether. Second, some of the suggested tobacco substitute crops, such as tomato and cotton, are equally or even more expensive to produce and utilise more damaging pesticides than tobacco (Keyser 2007). Third, two of the tobacco substitute crops suggested most often, namely soybean and sugarcane, are known to be a major cause of the high deforestation rates in countries such as Brazil and Argentina due to large crop area expansions (Barona *et al*. 2010). This underlines the argument that curtailing tobacco production may not necessarily be a solution to the problem of deforestation. A study by Nsiku and Botha (2007) notes that, although Malawi has one of the highest deforestation rates in Africa, over 80% of total tobacco production in Malawi does not require firewood for curing. This suggests that most of the deforestation in Malawi may not be caused by tobacco production. Fourth, debts and income losses are not particular to tobacco crop alone, nor do the income losses in tobacco occur perpetually. There have been years when tobacco has done well and its proceeds have been used to build houses and have been re-invested in other agricultural activities (Tobin & Knausemberger 2007). Fifth, the use of child labour is also not peculiar to tobacco production alone. Child labour is evident in the production activities of many other crops and economic sectors in developing countries (Jaffee 2003), suggesting that child labour is linked more to poverty than to tobacco production.

Regardless of the merit of the advanced arguments, the anti-tobacco campaigns have had mixed outcomes in the global production and marketing of tobacco. For instance, since the 1990s, tobacco production has decreased by 1.3% in developed countries, but it has increased by 5.7% in developing countries (Guindon *et al*. 2015). This has led to a steady increase in global production of 1% per annum (Jaffee 2003). While the anti-tobacco campaigns have also led to decreased per capita tobacco consumption, the total number of smokers has increased steadily, from 1.1 billion in 1990 to 1.3 billion in 2010 (Guindon *et al*. 2015). The number of smokers is projected to increase further to 1.7 billion by 2025 (Ng *et al*. 2014). The anti-tobacco campaigns have also, over the years, contributed to the instability of the global tobacco markets and profitability (Wakefield *et al*. 2008; Guindon *et al*. 2015). Since 1996, there has been reduced tobacco production by the estate sector in Malawi. The reduction has been attributed to a number of factors, such as theft of tobacco due to intermediate buyers and liberalisation of tobacco markets to smallholder farmers, resulting in tenants leaving tobacco estates to grow their own tobacco (Van Donge 2002). However, Jaffee (2003) estimated that more than 50% of tobacco estates had abandoned tobacco production due to price volatility. On the other hand, smallholder farmers in Malawi, mainly due to the lack of viable crop alternatives, have almost tripled tobacco production – from 49 million to 113 million tons per year (Jaffee 2003). Despite the increased tobacco production by smallholder farmers in Malawi, its contribution to the Malawi economy has been on the decline (Jaffee 2003). In addition, the profitability of tobacco in Malawi depends on global rather than national demand, as its internal consumption within Malawi is negligible (Prowse 2013). This means that the anti-tobacco campaigns, if successful, would critically

affect the demand and marketing of tobacco on the global level, and potentially crush the tobacco industry and the economy of Malawi.

2. Justification of research

Finding and promoting feasible tobacco diversification options are therefore critical for both farmers' welfare and the Malawi economy. Although a number of Malawian government policies and strategies seek to diversify tobacco (GoM 2011, 2012b), no comprehensive analysis has been done to date to understand the effect of tobacco substitution on consumer welfare, producer revenues and the government's forex earnings. Previous studies (Nakhumwa *et al*. 1999; Tsonga & Mataya 2001; Jaffee 2003; Keyser 2007) mostly used the gross margin analysis (GMA) methodology to analyse tobacco substitute crops. The GMA methodology disregards principles of demand and supply and also fails to analyse alternative crop combinations for farmers. Further, no scientifically determined recommendations on the best levels of tobacco substitution exist. In order to fill this knowledge gap, a partial equilibrium model of the Malawian Agricultural Sector (Kachulu 2017) was used to analyse tobacco diversification options over the period 2010 to 2070. This study is therefore a step ahead of previous studies, as it incorporates future demand and climate change effects in estimating crop and land-use investment to decide alternatives to tobacco production within the smallholder agriculture sector in Malawi.

3. Methods

3.1 Model description

As outlined above, the questions raised in the introduction were analysed using the Malawi Agricultural Sector Model (MASM), of which a detailed description appears in Kachulu (2017). In the next paragraphs, a description of MASM is outlined briefly. MASM is an integration of a crop biophysical model and a partial economic equilibrium model. It is a bottom-up and dynamic model that covers a 60-year period, from 2010 to 2070, and analyses the effects of different policy decisions or scenarios on the Malawian agricultural sector by considering the resource endowments, crops, crop technologies, agricultural markets, population growth, income changes and trade.

3.2 Data sources

MASM is a data-intensive model (Kachulu 2017). The MASM data on national population, farming population, population growth rate and income levels were sourced from the Integrated Household Survey (GoM 2012a) and the National Census and Livestock Survey (GoM 2012b). The historical or observed crop areas and crop yield data (2005-2010), consumption levels and crop product prices for 2010 were sourced from the Department of Agro Surveys (GoM 2014) and the Malawi Agricultural Commodity Exchange (MACE 2014). The soil data were sourced from the Department of Land Resources and Conservation through the Land Resource Evaluation Project Database (GoM 1991). MASM is designed for the worst possible climate scenario and uses Representative Concentration Pathway 8.5 (RCP8.5) emission scenario. Based on a study by Gama *et al*. (2014), MASM uses the MIROC5 General Circulation Model (GCM), which was found to have the best fit in replicating Malawi observed climate data among the 20 other GCMs that were evaluated. The daily climate data in MASM (precipitation, maximum and minimum temperatures, and relative humidity), which were downscaled using self-organising maps (Hewitson & Crane 2006) from MIROC5 under RCP 8.5, were provided by the Climate Systems Analysis Group of the University of Cape Town.

3.3 Biophysical crop yield simulation

MASM uses the Environmental Policy Integrated Climate (EPIC) model (Williams 1995) to analyse changes in crop productivity due to climate change. The selection of EPIC in MASM is based on its capabilities to stimulate multiple crops concurrently, and also considering that EPIC has previously been used and validated widely in climate crop impact studies in sub-Saharan Africa (Adejuwon 2005; Schmid *et al*. 2006). EPIC functions in daily time steps and simulates crop growth by predicting the combined effects of crop technologies, water and nutrient availability in soils (Williams 1995). The leaf solar radiation interception is converted into ground and above-ground biomass, from which the economic yield is deduced as a product of crop biomass and crop-specific harvest index.

3.4 Technology selection

The crop simulation in MASM was done on all the major crops grown in Malawi (cassava, cotton, groundnuts, maize, paprika, rice, sorghum, soybean, sugarcane and tobacco). The selected crops were also simulated under the main crop management technologies or practices observed in Malawi (conventional subsistence, conservation agriculture, *Falbedia albida*, optimal fertilisation and intensive farming). The crop and technology selection in MASM was based on observed or historical crop and technology hectarage between 2005 and 2010 (GoM 2014). The selected crops and technologies contributed to over 95% of the total area under crop production in the observed years. In MASM, subsistence farming represents a convention technology where soils are tilled, rainfed dependent, nitrogen applied at 30% than otherwise recommended (GoM 2014). Conservation agriculture represents the absence of tillage, with a soil cover of at least 30%, is rainfed dependent and nitrogen is applied as in subsistence farming, but complemented with decomposed biomass from stock cover. *Falbedia albida* is an agroforestry type of technology and depicts conditions where soils are tilled, are rainfed dependent, and nitrogen is applied as in subsistence farming but complemented with decomposed biomass from *Falbedia albida* tree leaves. Under optimal fertilisation, soils are tilled, are rainfed dependent, and nitrogen is applied as recommended (GoM 2014), hence there is no nitrogen stress. Intensive farming represents a technology whereby soils are tilled and irrigated, and nitrogen is applied as recommended by the Government of Malawi (2014), hence there is no water and nitrogen stress. Intercropping, which is common among smallholder farmers, was not selected, mainly due to the lack of data on intercropping.

3.5 Criteria for crop selection in this study

In this study, not all MASM crops were selected. The crop selection process and criteria are presented in Figure 1. Firstly, the crop selection was built on previous analyses by Nakhumwa *et al*. (1999) and Tsonga and Mataya (2001), who, upon wide consultations with stakeholders in Malawi, listed beans, cassava, cotton, groundnuts, maize, macadamia, millet, paprika, peas, rice, sorghum, soybeans and tea as alternatives for tobacco. Secondly, all the food crops (beans, cassava, maize, millet, peas, rice and sorghum) were excluded, as these crops are usually consumed locally and do not contribute much to forex earnings. However, soybean and groundnuts were retained due to increased external market opportunities for such crops. The decision to exclude food crops is also based on Nakhumwa *et al*. (1999) and Tsonga and Mataya (2001), who recommended that, being a food-insecure country, Malawi may produce food crops as a way of saving forex, but not primarily for forex generation or the export market. Thirdly, as this study deals with smallholder farmers, tea and macadamia, which are grown almost exclusively on large commercial farms, were excluded. Despite sugarcane missing from a list of crops in earlier studies (Nakhumwa *et al*. 1999; Tsonga & Mataya 2001), it was added following the recent efforts by the Government of Malawi to promote sugarcane production and processing among smallholder farmers through the Greenbelt Initiative (Chinsinga 2011; Kalinga-Chirwa *et al*. 2011). The study therefore remained with cotton, groundnuts, paprika, soybeans and sugarcane as potential substitute crops for smallholder farmers. The proportion of land devoted to

staple food crops and the selected cash crops were assumed to remain the same throughout the simulation period.

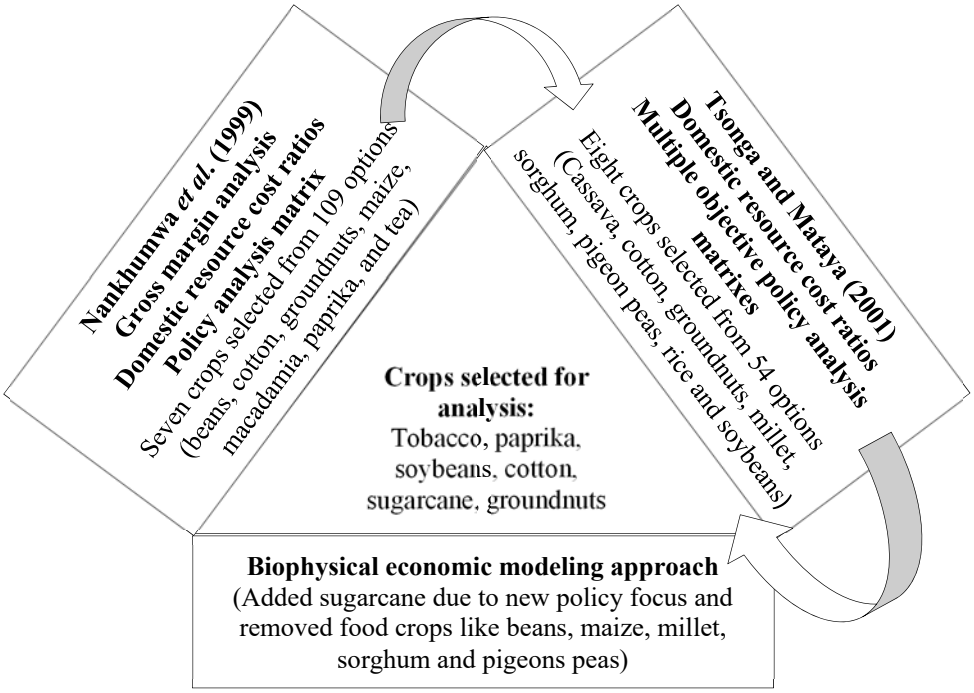

Figure 1: Process and criteria for selecting tobacco substitute crops

Adapted from Kachulu (2017) and Tsonga and Mataya (2001), who conducted nation-wide consultations to select potential tobacco substitute crops based on market potential, research support and extension services, among others.

3.6 Aggregation of land use and welfare levels

In MASM, crop yields are simulated from 1 300 homogenous response units (HRUs). HRUs are areas with similar soil types, and within the same slope category and altitude range (Schmid *et al*. 2006). Crop yields from HRUs are aggregated into extension planning areas (EPAs), which are considered as the smallest agricultural planning and administrative regions in Malawi. The average EPA crop yields ($\bar{\gamma}_{j,m,t,r}$) are thus estimated as a product of HRU yields ($\gamma_{j,m,t,r,h}$) and HRU areas ($\beta_{i,t,r,h}$), divided by the respective EPA area ($\sum_h \beta_{i,t,r,h}$); where (j) is crop type, (m) is crop technology option, (t) is study period, (h) is HRU and β is the arable land resource endowment. The crop activity or land-use levels are then aggregated from EPAs into 28 districts and eight agricultural development divisions (ADDs), whereas the effect of tobacco substitution on welfare is aggregated and presented at the national level (Figure 2).

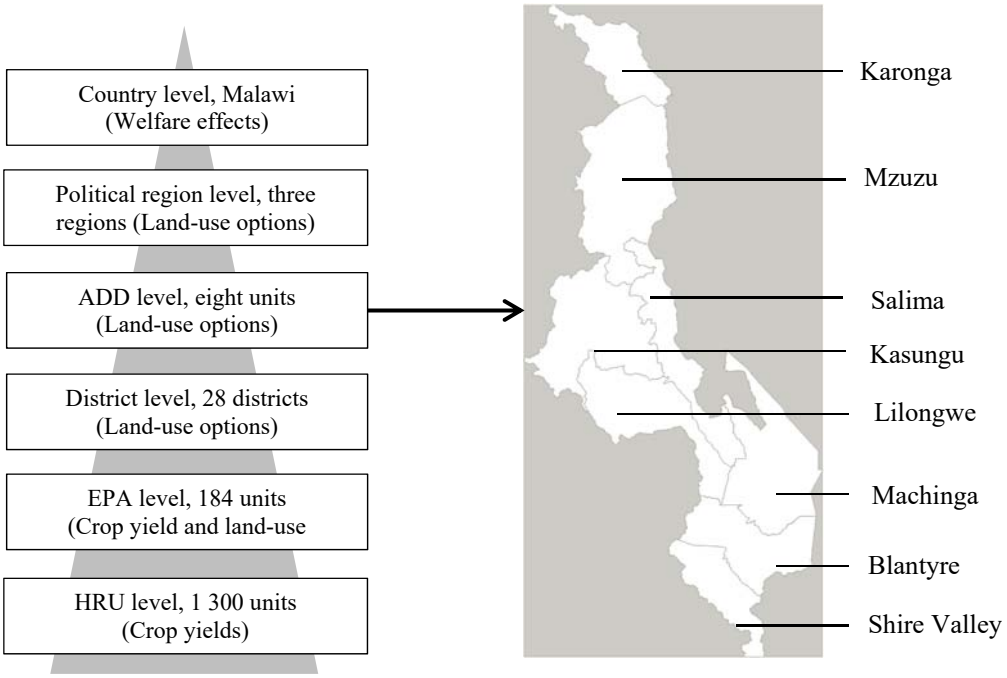

Figure 2: Bottom-up data aggregation approach and regional levels used in this study
HRUs = homogenous response units; EPA = agricultural extension planning areas; ADD = agricultural development division

3.7 Study scenarios

The analysis in this study proceeds as follows: First, a baseline scenario is run ("observed"), where business as usual is continued until 2070 and where crop mix decisions are restricted to observed levels of the base year, i.e. 2010. This scenario analyses changes in welfare when no measures are taken to adapt to the expected changes in climate. In this scenario, tobacco remains part of the crop mix; however, farmers continue operating at the observed, other than the optimal, crop levels throughout the study period. Second, a scenario is run in which tobacco remains part of the crop mix, but all crop activities are at the optimal level ("continue"). This scenario analyses welfare changes, in terms of which farmers adapt to climate change and therefore are assumed to operate at optimal crop-mix and land-use adaptation levels. Third, a scenario is run in which crop activity levels are at optimal levels, but tobacco is removed from the crop mix ("curtail"). This scenario analyses welfare changes when farmers adapt to climate change, but where tobacco is no longer among the crops grown in Malawi. In the "curtail" scenario, land use is therefore restricted to crops other than tobacco.

3.8 Estimating welfare changes

The objective function (1) estimates the consumer welfare (W) under all scenarios of "observed", "continue" and "curtail". Consumer welfare is an integral product of demand ($Q_{j,t,r}$) and market price ($p_{j,t,r}$), summed across all crop products (j), all study periods (t) and all regions (r), minus the costs of production ($\text{ç}_{j,m,t,r} \,.\, L_{j,m,t,r}$) and costs of trade ($\text{ţ}_{r,\tilde{r}} \,.\, T_{j,m,t,r,\tilde{r}}$), and where ($\text{ç}_{j,m,t,r}$) is the unit cost of production, ($L_{j,m,t,r}$) is the actual hectarage used, ($\text{ţ}_{r,\tilde{r}}$) is the cost of unit trade between regions, and ($T_{j,t,r,\tilde{r}}$) is the level of trade between regions. Indices (r) and ($\tilde{r}$) denote production and the export regions respectively:

$$\boldsymbol{W} = \sum_{\boldsymbol{t}} \begin{pmatrix} \sum_{j,r} \left[\int \boldsymbol{p}_{j,t,r} \left(\boldsymbol{Q}_{j,t,r} \right) \boldsymbol{dQ}_{j,t,r} \right] \\ - \sum_{\boldsymbol{j,m,r}} \left(\varsigma_{\boldsymbol{j,m,t,r}} \cdot \boldsymbol{L}_{\boldsymbol{j,m,t,r}} \right) \\ - \sum_{\boldsymbol{j,\tilde{r},r}} \left(\mathrm{t}_{\boldsymbol{r,\tilde{r}}} \cdot \boldsymbol{T}_{\boldsymbol{j,t,r,\tilde{r}}} \right) \end{pmatrix} \quad (1)$$

Producer revenues (R), as in (2), are estimated as the product of crop demand ($Q^*_{j,t,r}$) and market prices ($p^*_{j,t,r}$) at equilibrium point, summed over all crop products (j), all study periods (t) and all producing regions in Malawi (r):

$$\boldsymbol{R} = \sum_{\boldsymbol{j,t,r}} \left(\boldsymbol{p}^*_{\boldsymbol{j,t,r}} \cdot \boldsymbol{Q}^*_{\boldsymbol{j,t,r}} \right) \quad (2)$$

Forex earnings (F), as in equation (**3**), are estimated as the product of crop demand ($Q^*_{,t,\tilde{r}}$) and crop price ($p^*_{j,t,\tilde{r}}$) in the external markets, summed over all crop products (j), all study periods (t) and all export regions ($\tilde{r}$):

$$\boldsymbol{F} = \sum_{\boldsymbol{j,t,\tilde{r}}} \left(\boldsymbol{p}^*_{\boldsymbol{j,t,\tilde{r}}} \cdot \boldsymbol{Q}^*_{\boldsymbol{,t,\tilde{r}}} \right) \quad (3)$$

3.9 Assessing tobacco substitutability

As tobacco is a major contributor to government forex earnings and farmers' producer revenues, whenever losses are incurred in the "curtail" in comparison to the "continue" scenario, the government or farmers are expected to take measures to minimise the losses. For poor countries, forex generation is critical, not just for government revenue, but for the entire economy. This situation is more evident in Malawi, where all inorganic fertilisers, fossils fuels and medicines are imported and depend to a great extent on forex earnings generated by tobacco. Forex earnings were therefore chosen as an example to estimate the required land-use adjustments (4) when the curtailing of tobacco leads to forex earnings losses ($F^* > F$), where F^* and F are forex earning levels under the "continue" and "curtail" scenarios respectively. It is expected that the government and farmers may increase external market opportunities for tobacco substitute crops, which currently have not yet been explored fully. In the model, this process is achieved by increasing the quantity demand in the export markets $\left(\sum_{t,\tilde{r}} Q^+_{j,t,\tilde{r}} \right)$ of crop (j) until the additional earnings equal forex losses ($F^* - F$), where ($p_{j,t,\tilde{r}}$) is the crop market price in the export region ($\tilde{r}$):

$$\sum_{t,\tilde{r}} Q^+_{j,t,\tilde{r}} = {(F^* - F)} \Big/ {\sum_{t,\tilde{r}} \left(p_{j,t,\tilde{r}} \right)} \qquad \forall_j \quad (4)$$

Associated with this are changes in the area devoted to the substitute crops in the producing areas (r), as shown in equation (**5**), where $\left(\sum_{m,t} L^+_{j,m,t,r} \right)$ is the additional crop area at the national level that is required to produce the crop quantity $\left(\sum_{t,\tilde{r}} Q^+_{j,t,\tilde{r}} \right)$ needed to offset forex losses ($F^* - F$), and ($\bar{\gamma}_{j,m,r}$) is the average yield $\left(\sum_t {\bar{\gamma}_{j,m,t,r}} \Big/ {n} \right)$ of crop (j) under management option (m) in producing region (r), and (n) is the number of years studied:

$$\sum_{m,t}\left(L^{+}_{j,m,t,r}\right) = \left(\sum_{t,\tilde{r}} Q^{+}_{j,t,\tilde{r}}\right)/\overline{Y}_{j,m,r} \qquad \forall_{j,r} \tag{5}$$

4. Results

4.1 Changes in cultivated crop areas

The differences between the areas devoted to different crops in the "observed" and "continue" scenarios (Figure 3) indicate that crop areas have to be adjusted beyond currently observed levels for land use to be optimal. Sugarcane, for instance, should be grown on a larger area, whereas smaller areas currently are observed to suffice for cotton and soybeans to attain optimal economic efficiency (Figure 3a). When tobacco is removed from the crop mix "curtail scenario", the total agricultural area of the selected crops decreases from 514 276 to 401 878 hectares (-22%) in comparison to the "continue" scenario. The absolute area devoted to the different crops (Figure 3a) decreases in three cases: 10% for cotton and sugarcane, and 1% for groundnuts; whereas soybean area increases by 5% and paprika by 30%. However, the relative area shares of all other crops increase (Figure 3b). The biggest increments are noted for groundnuts (+12.2%) and soybeans (+9%), followed by cotton (+2.4%), sugarcane (+0.7%) and paprika (+0.4%).

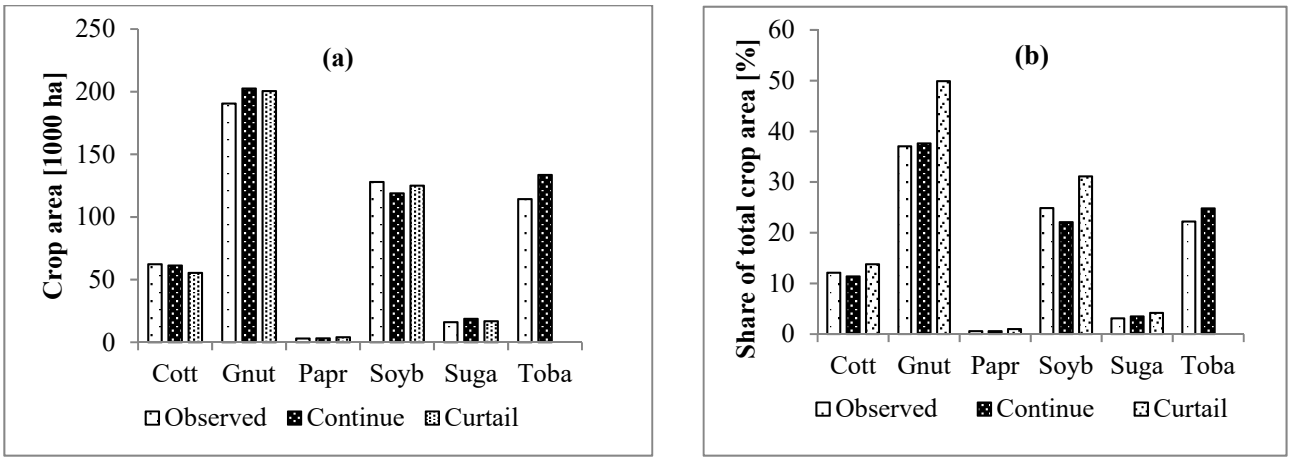

Figure 3: Land use of selected crops under different tobacco production decisions
Cott = cotton; Gnuts = groundnuts; Papr = paprika; Soyb = soybeans; Suga = sugarcane; Toba = tobacco

Changes in land use at the different agricultural development division (ADD) levels are shown in Table 1, with the curtailing of tobacco leaves, groundnuts and soybeans as major crops in the Karonga, Mzuzu, Kasungu, Lilongwe, Machinga and Blantyre ADDs. For the Salima and Shire Valley ADDs, on the other hand, sugarcane and cotton become major crops respectively. Under the tobacco curtail, technology use changes as well, which in turn reduces crop land use in the Karonga, Mzuzu, Kasungu, Machinga and Shire Valley ADDs, but increases crop land use in the Lilongwe and Blantyre ADDs respectively.

Table 1: ADD crop mix and land-use levels due to different tobacco production decisions (scenarios)

Region	ADD	Scenario	Area share (%)						Total area	
			Cott	Gnut	Papr	Soyb	Suga	Toba	1 000 ha	Δarea
North	Karonga	Observed	9.93	41.6	0.15	32.44	0.11	15.8	20.043	0.00
		Continued	8.36	41.38	0.18	29.72	0.13	20.25	17.050	-14.9
		Curtailed	7.23	57.68*	0.26	34.65*	0.20	0.00	18.920	-5.61
	Mzuzu	Observed	0.04	42.45	0.49	16.19	0.05	40.81	59.345	0.00
		Continued	0.05	37.68	0.51	13.84	0.06	47.88	72.946	22.91
		Curtailed	0.09	75.13*	1.19	23.49*	0.13	0.00	57.332	-2.76
Central	Kasungu	Observed	0.54	42.27	0.41	22.21	0.04	34.55	131.931	0.00
		Continued	0.48	38.60	0.41	18.49	0.04	42.00	72.503	-45.04
		Curtailed	1.41	57.72*	0.75	40.06*	0.09	0.00	30.627	-76.78
	Salima	Observed	15.49	25.03	0.35	27.81	19.98	11.37	25.936	0.00
		Continued	12.83	26.05	0.37	22.74	23.28	14.75	16.865	-34.97
		Curtailed	10.11	30.71*	0.58	20.60	38.02*	0.00	8.871	-65.79
	Lilongwe	Observed	11.97	29.28	2.00	29.95	0.04	26.78	86.717	0.00
		Continued	8.83	31.72	1.89	26.56	0.05	30.97	95.967	10.66
		Curtailed	7.94	56.07*	2.51	33.45*	0.06	0.00	95.099	9.66
South	Machinga	Observed	16.85	42.05	0.09	32.79	0.05	8.20	99.224	0.00
		Continued	12.95	46.88	0.09	28.18	0.05	11.88	119.75	20.65
		Curtailed	17.66	48.14*	0.09	34.08*	0.06	0.00	84.608	-14.73
	Blantyre	Observed	5.81	50.2	0.59	28.65	0.18	14.6	45.400	0.00
		Continued	9.90	44.71	0.50	25.45	0.28	19.18	90.679	99.73
		Curtailed	12.87	42.46*	0.91	43.31*	0.48	0.00	63.230	39.27
	Shire Valley	Observed	56.70	10.71	0.07	8.35	23.29	0.90	45.680	0.00
		Continued	46.45	16.4	0.10	8.03	27.32	1.73	52.662	15.28
		Curtailed	51.02*	12.18	0.08	6.86	29.89*	0.00	43.195	-5.44

ADD = Agricultural development division. Observed = the actual observed crop areas in 2010, as provided by the Ministry of Agriculture in Malawi (GoM 2014). Continued = scenario in which tobacco is still being grown. Curtailed = scenario in which tobacco is no longer grown. Cott = cotton, Gnut = groundnuts, Papr = paprika, Soyb = soybeans, Suga = sugarcane, Toba = tobacco. * = leading crops in respective ADDs when tobacco is curtailed.

4.2 Changes in welfare, producer revenues and forex earnings

The removal of tobacco from the crop mix "curtail scenario" results in consumer welfare loss (3%), producer revenue loss (44%) and forex loss (73%), as shown in Table 2. Local consumer welfare loss is relatively low, as Malawians are not the main consumers of tobacco. On the other hand, foreign consumer losses would be expected to be higher, as foreign consumers are the primary consumers of tobacco produced in Malawi.

Table 2: Welfare changes under different tobacco production decisions

	Local consumer welfare		Producer revenues		Forex base	
Scenario	($ million)	Loss (%)	($ million)	Loss (%)	($ million)	Loss (%)
Continued	45 026	-	41 128	-	24 688	-
Curtailed	43 527	3.3	22 864	44.4	6 636	73.1

As displayed in Figure 4a, under the "continued" scenario, tobacco contributes over 45% of producer revenues, followed by sugarcane (26%) and groundnuts (16%). When tobacco production is curtailed, sugarcane becomes the main source of producer revenue for farmers (47%), followed by groundnuts (29%) and soybeans (15%). Similar trends are also observed in the case of forex generation (Figure 4b), where tobacco contributes over 75% of forex earnings under the "continued" scenario. When tobacco is curtailed, sugarcane becomes the main contributor to forex generation (44%), followed by groundnuts (23%) and cotton (17%).

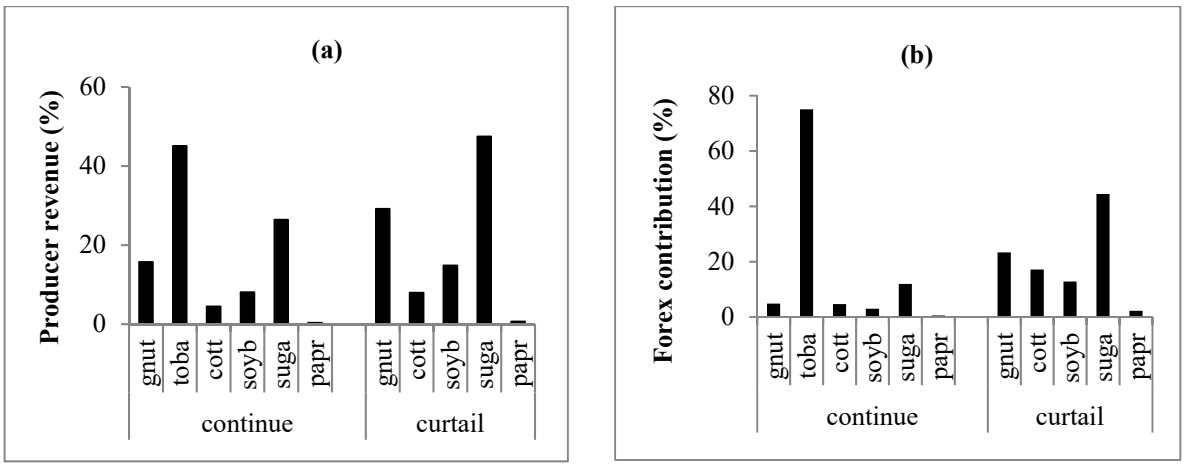

Figure 4: Crop contribution to producer revenues and forex earnings under different tobacco production decisions (scenarios)

Gnuts = groundnuts; toba = tobacco; cott = cotton; soyb = soybeans; suga = sugarcane; papr = paprika

4.3 Alternatives to avert forex loss due to tobacco curtailment

As already shown in Table 2, the government of Malawi loses 73% of forex earnings under smallholder agriculture when tobacco is curtailed. In order to avert forex losses, additional external market opportunities need to be opened up. The required additional external market and crop area expansion for each of the five tobacco substitute crops were evaluated separately (Table 3). Intensive farming technology, which gives the highest yield, was selected to estimate the additional required crop area in order to reduce pressure on already scarce and restricted land resources under smallholder farmers in Malawi. Paprika required the highest market expansion factor – of 39 – when compared to the other selected crops (Table 3, 2nd column). In this case, an additional 98 700 hectares would need to be devoted to paprika production (Table 3, 3rd column). The market expansion factor for the other crops is much lower, with cotton coming second with a factor of 2, and groundnuts being the lowest with a factor of 0.8. The area required to meet the demand of these market expansions is also much smaller for other crops when compared to paprika. An expansion of the cotton market by a factor of 2 would require an additional 82 961 hectares. Groundnuts require a market expansion factor of 0.8 and an additional 76 181 hectares. In the case of sugarcane, the market would have to be expanded by a factor of 0.9 and its hectarage increased by 14 616 hectares (Table 3, last row). In addition, sugarcane has the lowest production costs when compared to other crops (Table 3, last column). This, in theory, would make sugarcane the prime candidate for substituting tobacco. However, it should be noted that the production of sugarcane, which is water intensive, might be restricted to only the lakeshore and lower shire areas. The final decision on which crop to promote, however, ultimately depends on the export market opportunities that the Malawian government may manage to negotiate with other countries.

Table 3: Required market and additional crop area to avert forex earning losses under the "curtail" scenario

Crop	Market expansion factor	Original area (1 000 ha)	Additional area (1 000 ha)	Estimated cost of production ($ million)
Cotton	2.1	55.378	82.961	32.39
Groundnuts	0.8	200.496	76.181	14.85
Paprika	39.2	4.058	98.700	19.94
Soybeans	1.2	125.064	95.750	22.30
Sugarcane	0.9	16.798	14.616	11.60

5. Discussion

In this study, the effect of continuing or curtailing tobacco production on land use, consumer welfare, producer revenues and government forex earnings under smallholder agriculture in Malawi were analysed. Curtailing tobacco production led to the abandonment of 22% of the current agricultural area at the national level. In some agricultural development divisions, such as Kasungu, the land abandonment rate reached values of over 30%. This trend reflects the current dependence of smallholder farmers on tobacco as a major income provider (Orr 2000; Prowse 2013), of which the proceeds are often used to finance the production of other crops. Thus, if tobacco is to be curtailed, not only would much of the area previously grown with tobacco be abandoned, but many other fields would be left fallow due to the lack of income from tobacco that supports the production of other crops that were not included in this study, such as maize. However, the decreased crop land use of 22% at the national level does not necessarily lead to low production, as the use of high-yielding technologies would still increase production at lower crop land usage.

The effects resulting from curtailing tobacco production are also reflected in welfare changes. A curtailing of tobacco results in a consumer welfare loss (3%), a producer revenue loss (45%) and a forex earnings loss (73%). These results agree with historical observations, where tobacco has for decades contributed between 60% and 80% of forex earnings and 40% of farmers' income within the agricultural sector (Tchale & Keyser 2010). The results also agree with the findings by Van der Merwe (1998), who noted that a curtailing of tobacco would result in net income and employment losses in Zimbabwe. Even though consumer welfare changes are lower (3%), the high losses in forex earnings (73%) would have a direct, negative effect on the importation of chemical fertilisers, medicines and fossils fuels, among others, thus affecting the entire economy of Malawi.

To avert forex earnings losses, both export markets and crop areas would have to be expanded to a degree that depends on the chosen substitute crop. The results show that, if tobacco production is curtailed, over 80 000 additional hectares under intensive farming would have to be devoted to the production of groundnuts, paprika or soybeans to cover the forex deficit. The results further indicate that sugarcane requires the least amount of additional area and production investments in replacing tobacco. Sugarcane production would be especially suitable for the Salima and Shire Valley agricultural development divisions (ADDs). These ADDs coincidentally form part of the target areas delineated for the Greenbelt Initiative (Kalinga-Chirwa *et al*. 2011). However, these findings differ from the findings of Jaffee (2003), who concluded that tomato and cotton were more profitable than tobacco and therefore viable substitutes. Even though this study did not include tomato, as it was not among the important crops in the observed data (2005 to 2010), the difference can mainly be attributed to the methodologies used. The methodology used by Jaffee (2003) did not consider demand restrictions, future socio-economic development (income growth) or future climate change scenarios. The recommendation of sugarcane as a substitute crop, however, has other policy and social implications. Firstly, its production would be restricted to the lakeshore areas and to the Shire Valley, as pumping water to upland areas would increase production costs. Secondly, sugarcane, being a water-intensive crop, may lead to potential conflicts due to the rise in water demand for sugarcane production.

While the results indicate, in theory, that the expansion of external markets may avert the forex deficit or income losses, the expansion of the export market is a huge challenge for poor countries and smallholder farmers in reality. There is therefore a need for the Malawi government to find steady external markets. Some markets, e.g. for paprika, have previously existed for a very short time and abruptly abandoned farmers in subsequent seasons. Export market access is also made more difficult by protectionism and the often stringent technical and phytosanitary standards in different importing countries (Kherallah *et al*. 2002; Jaffee & Henson 2005). For instance, groundnuts have previously been promoted by the Malawi government. However, due to high levels of aflatoxin (Matumba *et al*.

2015), external markets for groundnuts have been a challenge for smallholder farmers (Minde *et al*. 2001). The expansion of external markets would, among other factors, require smallholder farmers to first acquire the necessary standards of production. Even when access to export markets is guaranteed, other challenges include lack of investments in storage and processing facilities, which, with the exception of tobacco, are mostly non-existent for smallholder farmers. For instance, sugarcane, which is currently being promoted among smallholder farmers, would require huge investments in processing facilities along the lakeshore areas. Similarly, the construction of ginnery facilities in the cotton-producing areas of Salima and Chikwawa, which are currently absent, would greatly reduce smallholder farmer transportation costs.

This study mainly assumed that the majority of smallholder farmers would still rely on the agricultural sector for their livelihoods and for income generation during the entire studied period (2010 to 2070), as has been the case since independence in 1964. The study, therefore, holds other sectors' growth constant in order to understand the effect of tobacco substitution on consumer welfare, producer revenue and forex generation within the smallholder agricultural sector. Whilst this assumption is logical, changes in other economic sectors such as mining or tourism might alter resource availability and the income levels of the population, and consequently lead to different results. It is also difficult, apart from observed data, to foretell which new crops might in future be produced under smallholder agriculture in Malawi. As noted by Kachulu (2017), the introduction of such future, and new but currently unknown or not yet popular, crops would also lead to different tobacco substitutability effects. This is generally considered as a limitation of the study.

6. Conclusions

This study has shown that the curtailing of tobacco would lead to huge losses in farmer producer revenues and the government forex base. The curtailing of tobacco would also decrease the production of other crops, which to some extent rely on income realised from tobacco sales. While the consumer welfare losses would be low, policy makers have to mainly consider the effects of huge forex earnings losses, which may have wider negative effects on the entire Malawian economy. The recommendation that sugarcane would be the most suitable tobacco substitute crop is based on the least additional crop area and external market expansion. However, any crop would potentially be a suitable substitute, depending on the existence of external market opportunities.

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