SUSTAINABLE TOBACCO PRODUCTION IN MALAWI: THE ROLE OF WOOD DEMAND AND SUPPLY

W. Trent Bunderson and Ian M. Hayes

Standard burley tobacco curing barn

Improved burley barn made from live Eucalyptus trees

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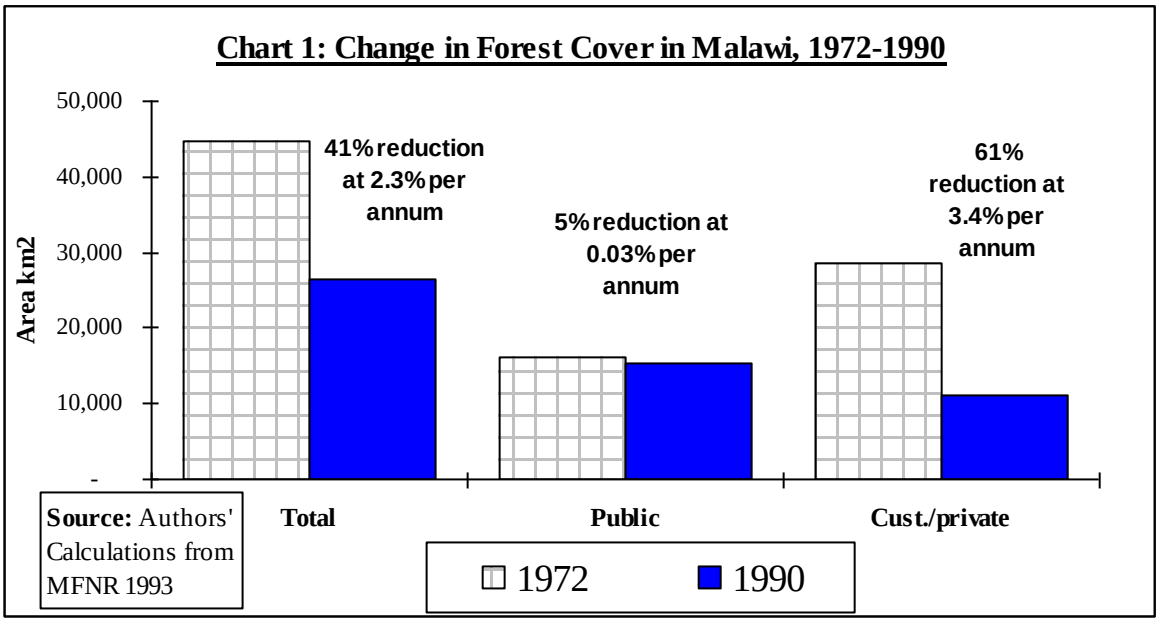
1.0 SITUATION ANALYSIS

The tobacco industry plays a vital role in Malawi's economy. Tobacco contributes significantly to the livelihood of most estates and many smallholder farmers. Tobacco exports also account for two thirds of Malawi's foreign exchange earnings. However, the sustainability of tobacco production is threatened by the declining supply of wood to meet growing household demands for fuel, building material and tobacco curing. Between 1972 and 1990, forest cover declined by 41%, from increased demands for farmland and wood (see **Chart 1**). This situation has serious implications for the tobacco industry.



As wood becomes more scarce and expensive, farmers will be forced to reconsider their tobacco options. Initially they will switch between varieties if they have this option. Flue-cured and fire-cured tobacco, which place the heaviest demands on fuelwood, will be replaced by burley. This is currently occurring in Southern Malawi where the shortage and high cost of wood has contributed toward a shift from southern fire-cured to burley. Without the option to substitute varieties, farmers will simply grow another crop that requires no wood. The less fuel-intensive air-cured tobacco varieties, such as burley, will also come under pressure as poles become scarce and expensive. With no intervention, the end result will be a marked fall in tobacco production over the next two decades.

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This paper examines methods to reduce deforestation in Malawi by modeling wood demand and supply in rural areas, with emphasis on tobacco producers. The impact of measures to alleviate this problem is assessed in the model. These include a combination of new tree planting, the adoption of energy efficient stoves and tobacco curing furnaces, and sustainable management of existing trees.

2.0 TREE PLANTING AND ENERGY EFFICIENCY INTERVENTIONS

In order to reduce deforestation, farmers need an enabling environment to achieve self-sufficiency in wood production. This objective can be approached from both the supply and demand (consumption) of wood.

2.1 Demand for Wood – Energy Efficiency Improvements

For simplicity, farmer demands for wood are split between household needs (primarily for cooking) and tobacco curing. Several improved wood stoves have been tested to improve energy efficiency. The earlier models were not accepted readily as their construction required materials that were not easily available in the rural areas. The Evangelical Lutheran Development Programme (ELDP) has been promoting an improved clay mudstove which overcomes this problem. From a simple tin mould costing about K25, any number of mudstoves can be made using only clay. The energy efficiency improvements are claimed to be in the region of 75% (James Chima, ELDP pers. comm.).

Wood-use efficiency can be improved for burley, flue-cured and fire-cured tobacco. Living barns are burley tobacco sheds made from live trees that replace upright poles, which reduce wood use by about 66%. With improved furnaces (such as the Malawi slot furnace) the high wood consumption of flue-tobacco can be reduced by a third (Tobacco Research Institute of Malawi, 1989). Gains in efficiency for fire-cured tobacco are limited to proper curing management (Mr. Balaka, ARET, pers.comm).

2.2 Wood Supply – New Tree Planting and Sustainable Management of Existing Trees

Tree planting must occur on a massive scale to meet growing wood demands. All sectors of the economy have roles to play, but success can be achieved only by the willing and active participation of farmers and other end-users. Ultimately, these are the people who possess the physical resources to make this possible. As such, they need basic support services: knowledge and resources with *empowerment* for action on a sustainable basis.

Since the scale of this challenge is beyond the capacity of conventional extension services, a tree pack programme is recommended as the core focus (along the lines of the Carlsberg Green Pack Programme). Such a programme offers a rapid, low cost, self-help approach for reaching large numbers of farmers with little extension support. It entails producing tree packs for sale to farmers, each with a number of potting tubes, a selection of tree seeds to meet different needs, and an instruction booklet on the uses of each species and how to plant them.

Each tree pack would contain seed of up to 5 species of trees in high demand by farmers. Among these could include *Acacia* spp., *Albizia* spp., *Bridelia micrantha, Burttdavya nyasica, Eucalyptus* spp., *Faidherbia albida, Gmelina arborea, Khaya nyasica, Melia azedarach, Senna* spp., and *Toona ciliata*. The wood from all these trees is suitable for fuel, and many have other uses. Choice of species will depend on farmer preferences and the environment. Numbers by species would vary with seed availability, intended tree use, anticipated preferences, and expected performance. All packs would contain instructions on growing trees.

Tree packs would be sold for a nominal fee (below cost) rather than giving them away free. The value of the tree pack will give farmers greater incentive to plant and care for the trees. Some of the proceeds could be used for farmer competitions with attractive prizes. A self-monitoring system could also be used to evaluate tree survival and growth. Training in nursery and outplanting procedures would be given to extension staff in the Ministry of Agriculture and Irrigation and ARET. These staff would help distribute the packs to farmers and train them in tree planting techniques.

Tree packs would be tailored for different types of farmers to meet most of their wood demands for household use and tobacco curing. The balance would be met from existing trees on and around their farms. With the reduced demands on these resources, farmers would receive additional training to use and manage their trees on a sustainable basis. Self-sufficiency in planting material would be encouraged by training farmers to collect their own seed, and assisting them to establish seed banks of selected species. Armed with this knowledge and experience, farmers would have the capacity to sustainably meet their full needs.

3.0 THE WOOD DEMAND AND SUPPLY MODEL

The model assumes a progression from the current state (also referred to as the no change scenario) of wood demand and supply in rural areas to an improved state over a twenty-year time horizon. The improved state assumes farmer adoption of new tree planting and energy-efficient technologies at rates discussed below. Individual wood requirements for household use and tobacco curing are modeled to examine long-term impacts on deforestation in Malawi. Demand and supply measures to alleviate this problem are then modeled to make recommendations for remedial action.

The model is based on the total rural population of Malawi, split into the smallholder and estate subsectors. Smallholders are differentiated between tobacco growers and non-tobacco growers. Among the tobacco growers, a distinction is made between burley, flue-cured, fire-cured, sun/air-cured and oriental tobacco growers.

3.1 Model Assumptions

Table 1 provides assumptions about different varieties of tobacco, including average yields and wood requirements per metric tonne of cured tobacco under current and improved circumstances. Numbers of smallholder households and estates are kept constant, but family size increases to reflect the growing population. The average size of a smallholder family is assumed to rise from 5 in Year 1 to over 7 in Year 20, while the average estate rises from 31 to 45 people over the same period.

The model assumes that households and estates currently harvest their wood needs from existing trees on and around their farms. **Table 2** lists assumptions about access to land for wood harvesting, while **Table 3** details assumptions on wood yield from existing trees. For convenience, new trees are assumed to be planted at a density of 5,000 trees/ha, yielding 14.3 m^3 wood per annum in a five-year rotation.

Table 1: Tobacco Assumptions

Tobacco Variety	Area / Farmer Ha	Tob Yield MT/ha	Current Wood Requirement (M^3/mt)	Improved Wood Requirement (M^3/mt)
Smallholder - Burley	0.15	1.08	2.79	1.05
- Flue-Cured	0.33	0.90	17.94	11.84
- Fire-Cured	0.05	0.58	16.57	13.26
- Sun/Air-Cured	0.05	0.66	1.43	1.43
- Oriental	0.20	0.55	1.43	1.43
Estate – Burley	3.40	1.25	2.79	1.05
- Flue-Cured	3.50	2.00	17.94	11.84

Source: Bunderson and Hayes (1995)

Table 2: Land Access Assumptions

Land Access	Agricultural Land	Forest	Plantation
Smallholder Land Access (ha)	1.11	0.53	0.01
Estate Land Access (ha)	26.24	5.38	0.01

Source: Bunderson and Hayes (1995)

Table 3: Wood Yield Assumptions

Existing Wood Yields	Mean Ann. Increment (M^3 /ha)	Standing Stock (M^3 /ha)
Intensive Agricultural Land	0.28	20.00
Extensive Agricultural Land	1.07	85.71
Private Plantation	14.29	132.86
Indigenous Forest	3.64	122.86

Source: Ministry of Forestry and Natural Resources (1993)

3.2 Individual Wood Demand and Supply: Improved vs No Change

Wood supply and demand characteristics are examined here to determine how many new trees need to be planted by each farmer. Calculations combine estimates of wood supplies from existing trees, plus a 50% adoption rate of energy improvements. The number of trees is based on a farmer spacing of 1 x 2 m which is more than double the recommended density, but it reflects how farmers plant trees due to limited land.

3.2.1 Smallholder Subsector

Wood Demand

Smallholder farmer wood requirements in **Year 20** are broken down by tobacco variety and household use in **Table 4**, which also compares the current and improved situations. No improvements in wood consumption are made with oriental and sun/air-cured varieties. Under the current situation, burley requires 158 trees for 0.15 ha of tobacco. This compares with 108 trees if 50% of farmers adopt living barns.

Flue-cured and fire-cured tobacco require large amounts of wood. With half the farmers adopting improved furnaces, an average of 0.31 ha of trees is required for 0.33 ha of flue-cured tobacco under the improved situation. Fire-cured tobacco improves marginally under the improved scenario with gains in efficiency limited to proper curing management. The average tobacco fuelwood requirement under the improved situation across all varieties is 132 trees, equivalent to 0.03 ha.

Table 4: Smallholder Tobacco Farmer Wood Demand Year 20

Tobacco Wood Demand	**Current Tree Situation**			**Improved Tree Situation**		
Variety and Area Grown	**Area ha**	**Wood M^3**	**Trees No.**	**Area ha**	**Wood M^3**	**Trees No.**
Burley (0.15 ha)	0.03	0.45	158	0.02	0.31	108
Flue-Cured (0.33 ha)	0.38	5.38	1,883	0.31	4.47	1,563
Fire-Cured (0.05 ha)	0.03	0.48	168	0.03	0.43	151
Sun/Air-Cured (0.05 ha)	NA	0.05	16	NA	0.05	16
Oriental (0.2 ha)	NA	0.16	54	NA	0.16	54
Total Wood Demand						
Household Wood Requirement	0.52	7.45	2,606	0.39	5.59	1,954
Average Tobacco Requirement	0.03	0.48	166	0.03	0.38	132
Total Wood Requirement	**0.55**	**7.92**	**2,773**	**0.42**	**5.96**	**2,087**

Fifty percent of all households are assumed to adopt improved wood stoves under the improved scenario. This reduces household wood consumption from 2,607 to 1,955 trees per household. Under these assumptions, the total wood requirement with tobacco drops from 2,733 trees (0.55 ha) under the no change scenario, to 2,087 (0.42 ha) with energy interventions. Non-tobacco smallholder farmers need to plant 1,954 trees (0.39 ha) to satisfy household wood requirements under the improved situation.

Wood Supply

Under the improved situation, the average smallholder tobacco grower needs to plant a total of 0.35 ha of trees in a 5-year rotation (see **Table 5**). One fifth of this area is planted each year. From Year 6, one fifth is harvested and then replanted or left to coppice, depending on the species. This equates to 350 trees per annum with a total of 1,750 trees per farmer over the rotation period. This meets **80%** of the average wood demand for tobacco and household needs. The balance is met from existing trees. By contrast, **only 7%** of total wood requirements are met on a sustainable basis under the no change scenario. Non-tobacco smallholder farmers need to plant 1,650 trees (0.33ha) over 5 years to meet their wood requirements under the improved situation.

Table 5: Smallholder Tobacco Farmer Wood Supply Year 20

Wood Supply	**Current Tree Situation**			**Improved Tree Situation**		
	Area ha	**Wood M^3**	**Trees No.**	**Area ha**	**Wood M^3**	**Trees No.**
Total New Tree Wood Production	0	0	0	0.35	4.99	1,748
Wood Production from Existing Trees	0.04	0.57	197	0.07	0.99	347
Total Wood Production		**0.57**			**5.98**	
% of Total Wood Req met by Production		**7%**			**100%**	

3.2.2 Estate Subsector

Wood Demand

Estate wood requirements in **Year 20** are broken down by variety of tobacco and household use in **Table 6**, which also compares the current and improved situations. Burley tobacco requires 4,116 trees for 3.40 ha of tobacco under the current situation. This drops to only 2,864 trees with 50% adoption of living barns. Tree demands for flue-cured tobacco drop from 4.8 to 4 ha with 50% adoption of improved furnaces. Under the improved situation, the average tobacco estate tree requirement across all varieties is 5,039 trees, equivalent to 1.22 ha.

Table 6: Estate Wood Demand Year 20

Tobacco Wood Demand	**Current Tree Situation**			**Improved Tree Situation**		
Variety and Area Grown	**Area ha**	**Wood M^3**	**Trees No.**	**Area ha**	**Wood M^3**	**Trees No.**
Burley (3.40 ha)	0.83	11.90	4,116	0.57	8.18	2,864
Flue-Cured (1.93 ha)	4.84	69.16	24,207	4.02	57.40	20,092
Total Wood Demand						
Household Wood Requirement	3.19	45.55	15,943	2.39	34.16	11,957
Average Tobacco Requirement	1.22	17.43	6,102	1.01	14.4	5,039
Total Wood Requirement	**4.41**	**62.99**	**22,045**	**3.40**	**48.56**	**16,996**

Fifty percent adoption of improved cooking stoves reduces household wood use from 15,943 to 11,957 trees per estate. Total wood requirements with tobacco drops from 22,045 trees (4.41 ha) to 16,996 (3.40 ha) with these energy interventions.

Table 7: Estate Wood Supply Year 20

Wood Supply	**Current Tree Situation**			**Improved Tree Situation**		
	Area ha	**Wood M^3**	**Trees No.**	**Area ha**	**Wood M^3**	**Trees No.**
Total New Tree Wood Production	0	0	0	1.83	26.18	9,165
Wood Production from Existing Trees	0.89	12.74	4,467	1.57	22.36	7,825
Total Wood Production		**12.74**			**48.54**	
% of Tot Wood Req met by Prodn		**20%**			**100%**	

Wood Supply

Under the improved situation, the average estate grower needs to plant a total of 1.83 ha of trees in a 5-year rotation (see **Table 7**). One fifth of this area is planted each year. From Year 6, one fifth is harvested and then replanted or left to coppice, depending on the species. This equates to 1,800 trees per annum for a total of 9,000 trees per estate over the rotation period. This meets **54%** of the average wood demand for tobacco and household needs. The balance is met from existing trees. By contrast, **only 20%** of total wood requirements are met under the no change scenario.

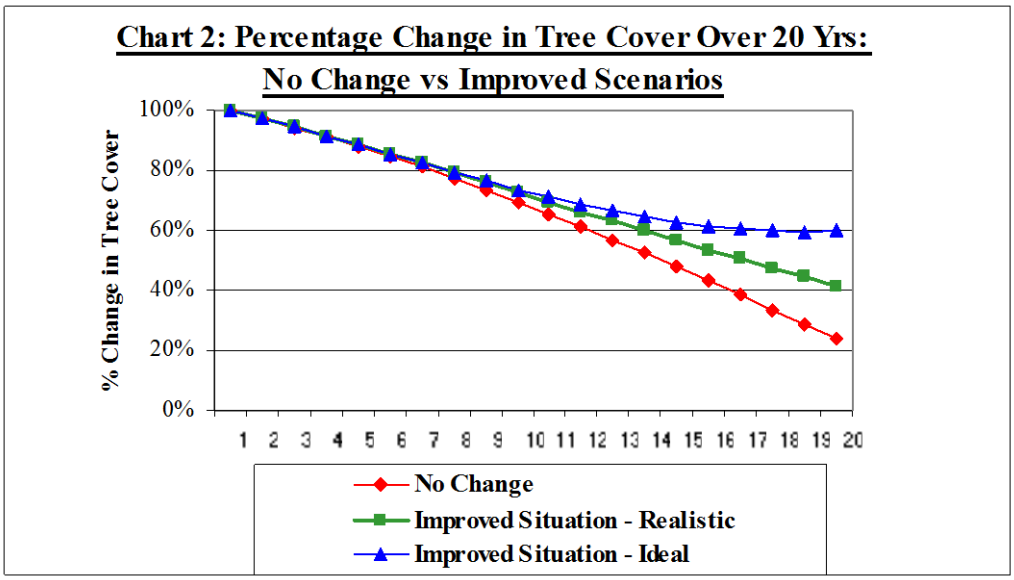
3.3 National Level Wood Demand and Supply – Impacts on Deforestation

With the interventions in place at the specified adoption levels, the national impact on deforestation is compared with the current situation.

3.3.1 No Change Scenario

With no intervention, estate and smallholder farmers will continue harvesting existing tree resources at unsustainable rates. The model of tree supply and demand predicts that tree cover will fall in rural areas by a **dramatic 80%** from current levels (**Chart 2** – No Change Situation). This clearly has serious implications for all farmers.

Wood for any use will be scarce and expensive. As such, it is probable that flue and fire-cured tobacco will no longer be a viable option for farmers. Air-cured tobacco production will also be affected due to wood demands for poles, roofing material and curing racks. Women and children will spend more time and energy gathering fuelwood, detracting from time better spent on farming, child care, education, and nutrition.



3.3.2 Improved Scenario

The target for tree planting over the next 20 years is a high, but with a potentially achievable adoption level of 50% for estate and smallholder tobacco growers, and 20% for other smallholders. This translates to 1.5 billion trees by 500,000 estate and smallholder farmers, each planting an average of 3000 trees. Direct input costs are estimated at US$22-25 million, or about US$50 per adopting farmer (**Table 8**). This will require about 1000 MT of tree seed, all properly tested, packed and delivered.

Table 8: Improved Scenario Summary Results over 20 Years

Farmers/Estates	**Total**	**US$/Farmer**
Target Number	472,590	50.00
Tree Planting	**Total (billion)**	**US Cents/Tree**
No. Trees Planted	1.48	1.5

Individual adopters of the proposed interventions will become self-sufficient in wood, with the **conservation equivalent of over 400,000 ha of indigenous woodland.** The national story is less rosy. Tree cover will continue to fall in twenty years, but at a much slower rate (see **Chart 2**-Realistic Improved Situation).

Ideally, the goal is to stabilize or reverse deforestation, but this is highly improbable given a required adoption rate of 100% for **all** farmers within 15 years (**Chart 2** – Ideal Improved Situation). Over the 20 year time period, this equates to planting a staggering 6.5 billion trees at a cost of US$97 million.

4.0 CONSTRAINTS AND NEEDS

Malawi is a small, densely populated country with a finite natural resource base. With no alternative fuels, reliance on wood energy threatens unsustained exploitation of forest resources. The resulting degradation endangers the integrity of agriculture and forestry, with far-reaching effects on fisheries, water supplies, hydro-power, infrastructure, industry, health and trade.

These pressures dictate the urgency to wisely use and manage the natural resource base to ensure long term productivity for future generations. The tree planting and improved energy interventions proposed could have significant impacts; but they must be accompanied by sound policy support nationwide to produce and disseminate needed inputs and services. This demands a coordinated approach among the public, private, NGO, and donor sectors in partnership with farmers. Key concerns include:

1. Creating awareness and support nationwide about the need for sound natural resource management, identifying the roles of all stakeholders through proper consultation.

2. Facilitating the transfer of needed knowledge and inputs to as many farmers as possible for maximum impact.

3. Increasing the supply of tree planting materials at local levels to meet farmer demands.

4. Producing and disseminating improved stoves for household use and more efficient tobacco curing technologies, (perhaps linked to donor or subsidized financing) to minimize needless waste of valuable forest resources.

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