Country Pasture/Forage Resource Profiles

MALAWI

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1. INTRODUCTION

Malawi is a landlocked tropical country with Zambia to the west, Mozambique to the south and east, and Tanzania to the north and east, lying between 9° 45' and 17° 5' S and 30 to 36° E (see Figure 1). The national borders encompass Lakes Malawi and Chilwa, which cover 2 440 km² leaving a land area of 9 408 km². The Northern region covers 2 690 km², the Central region 3 559 km² and the Southern region 3 176 km²; 40% of the total land area is suitable for agriculture (Table 1).

The year 2000 agricultural population was estimated to be 11 million people, with 85% of the total population living in rural areas. Malawi is one of the most densely populated countries in sub-Saharan Africa. Population density rises from 46 persons/km² in the Northern region to 144/km² in the South with the most populated districts such as the Shire Highlands in the south containing over 265 persons/km². Population grew at a rate of 3.7% per year between 1977 and 1987 but the rate of increase declined to 1.9% per year (Table 2) in the following ten years. According to the World Factbook the estimated July 2006 population was 13 013 926 and the growth rate 2.38%.

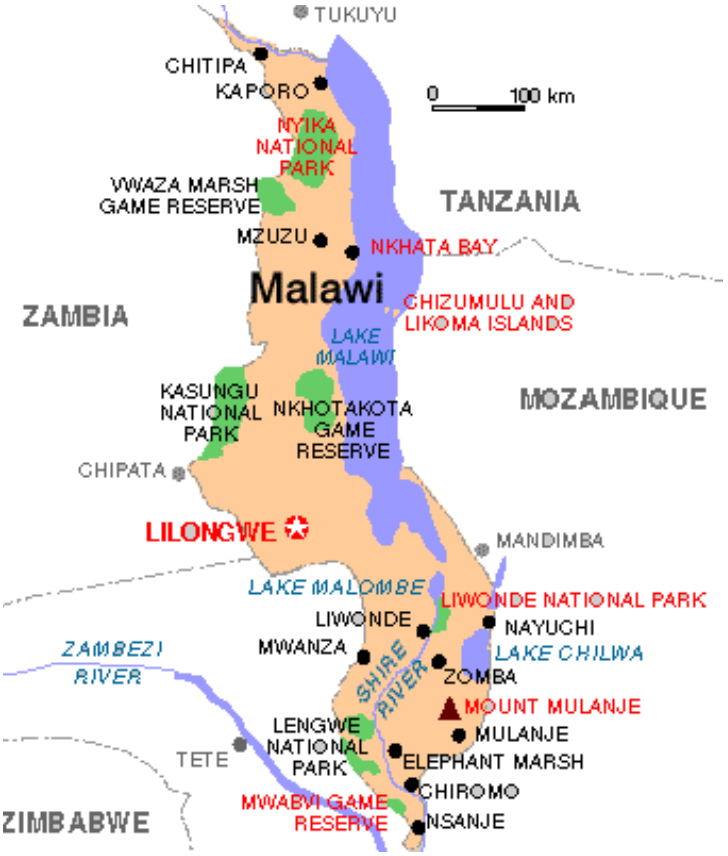

Figure 1. Map of Malawi

Table 1. Land use in Malawi (ha x10³)

Forest and woodland	3 700
Permanent pasture	1 850
Permanent crops	125
Arable	1 875
Total agricultural area	3 850
Non-arable and non-permanent crops	7 408
Lakes Malawi and Chilwa	2 440
Total land area	9 408
Total area	11 848

Source: NSO, 2000

Table 2. Agricultural population in Malawi, 1988–2000

Million persons	1988	1990	1992	1994	1996	1998	2000
Agric pop.	7.59	8.17	8.79	9.37	9.88	10.42	10.99

Source: NSO, 2000

Most of the arable land is under traditional/customary tenure system. Cultivation rights, rather than ownership is granted by the chief through the village headman. Matrilineage is common in the centre and south while patrilineage is common in the north. In the matrilineal system, where the husband leaves his home to live with the wife, cultivation rights are inherited by the wife. By the late 1980s over 56% of households were on holdings of less than 1 ha, and a further 20% on 1.0–1.5 ha. Because of pressure on land there is little opportunity for fallow and rotation to restore soil fertility, and smallholders have expanded their cultivation to marginal, less fertile soils often on hill slopes which are not suitable for intensive cultivation, leading to woodland depletion, soil degradation and erosion. Rainfed agriculture predominates, dependant on a single rainy season between November and April. The growing season varies in length from less than 120 days to over 210 days (Figure 2). Only 10 000 ha of land is currently irrigated, 5% of the potential irrigated area, largely on sugar estates. Other irrigated crops include rice and vegetables.

Table 3. Crop area and production in Malawi, 1995

Area (ha 103), production (t)	Karonga	Mzuzu	Kasungu	Salima	Lilongwe	Machinga	Blantyre	Shire Valley
Cropped land	124	374	351	80	522	454	521	389
Maize*	24.5 (n.a.)	88.9 (64 348)	203.8 (123 187)	78.1 (n.a.)	343.8 (233 367)	262.7 (143 795)	282.1 (211 863)	73.2 (n.a.)
G/nuts	4.7 (2 492)	14.8 (8 858)	33.8 (29 222)	8.5 (8 137)	37.0 (26 642)	20.0 (15 034)	17.4 (10 974)	3.1 (2 314)
Beans	5.5 (2 683)	50.1 (8 813)	25.4 (9 470)	0.5 (486)	71.7 (21 811)	11.8 (6 385)	23.1 (9 444)	1.5 (1 368)
Pigeon pea	0.9 (442)	0.1 (31)	n/a (n.a.)	2.2 (1590)	0.1 (55)	33.3 (28 415)	78.5 (46 347)	7.5 (6 335)
Cowpea	0.3 (81)	0.2 (56)	0.6 (178)	2.2 (875)	2.6 (898)	20.9 (9 280)	27.1 (8 595)	14.7 (8 784)
Soya	0.4 (286)	5.0 (3 446)	11.6 (10 689)	1.0 (707)	16.9 (12 051)	1.6 (1 033)	4.0 (1 778)	0.1 (48)
Bamabra nuts	0.4 (239)	0.5 (263)	2.7 (1 797)	0.4 (249)	1.9 (1 058)	0.3 (520)	1.3 (73)	0.2 (4 759)

** Maize production data estimated for 1993/94, Heisey and Smale, 1995*
n/a not available
Source: Moriniere and Chimwaza, 1996

At the same time per capita food production has been falling, moving from an index of 100 in 1978–81 to 75 by 1991, reaching only about 87% of the recommended minimum daily calorie consumption. Maize is the main staple of the Malawian diet, covering 76% of smallholder farmland. In the late 1960s, intercropping was found on 94% of the maize area, but this had fallen sharply by 1980. Other food crops include rice, sorghum and millet. Legumes, beans, pigeon pea and groundnuts are traditionally grown by smallholders (Table 3). Pigeon pea in particular is important in the densely populated Blantyre district, providing food, animal forage and being beneficial to soil fertility. Cassava, potato and sweet potato are more locally based. The area planted to cassava, often intercropped with maize, has increased sharply over the past 10 years particluarly in densely populated southern areas. Tobacco is the dominant cash crop, providing 71% of export earning from both large scale and small scale farming sectors. Other cash crops include cotton, sugar, tea and coffee.

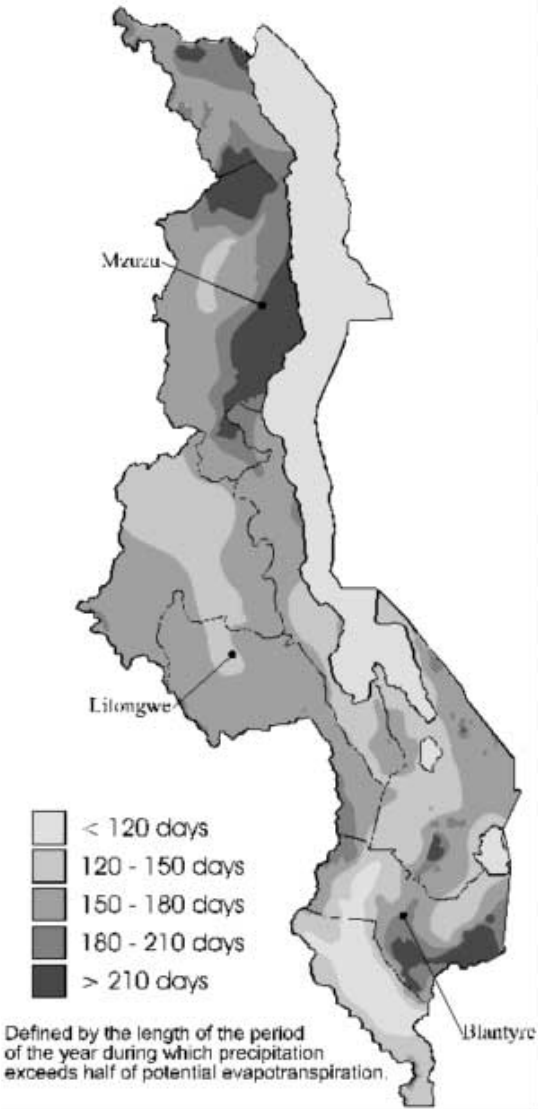

Figure 2. Length of growing period in Malawi
(Source: Moriniere and Chimwaza,1996)

2. CLIMATE, LANDFORMS AND SOILS

2.1 Climate

The climate in Malawi changes from semi-arid in the Lower Shire Valley, semi-arid to sub-humid on the plateaux and sub-humid in the highlands. Most of the country receives between 763 and 1 143 mm rainfall per year. There are three main areas with precipitation over 1 524 mm: Mulanje, Nkhata Bay and the northern end of Lake Malawi (Figure 3). Almost 90% of rainfall occurs between December to March, with no rain at all between May to October over most of the country.

Mean annual temperatures vary with altitude, ranging from 25 °C in the Lower Shire Valley to 13 °C on the Nyika Plateau. Frost may occasionally occur in lower lying land on the plateaux, but is not a significant limiting factor in pasture production.

2.2 Landforms, agro-ecological zones and soils

There are 5 main landform areas, the Highlands, Escarpments, Plateaux, Lakeshore and Upper Shire Valley, and the Lower Shire Valley:

The Highlands: These consist of isolated mountains between 1 320–3 000 m asl. Extensive highland plateaux are found in the Nyika, Viphya and Mulanje, while Dedza and Zomba are more isolated. Slopes can become precipitous, and soils are predominantly leached latosols.

The Escarpments: These are associated with major fault lines along the edge of the Rift Valley, running from Karonga in the north to Nsanje in the south. They are also found around the highland plateaux and mountains. Soils are predominantly thin latosols.

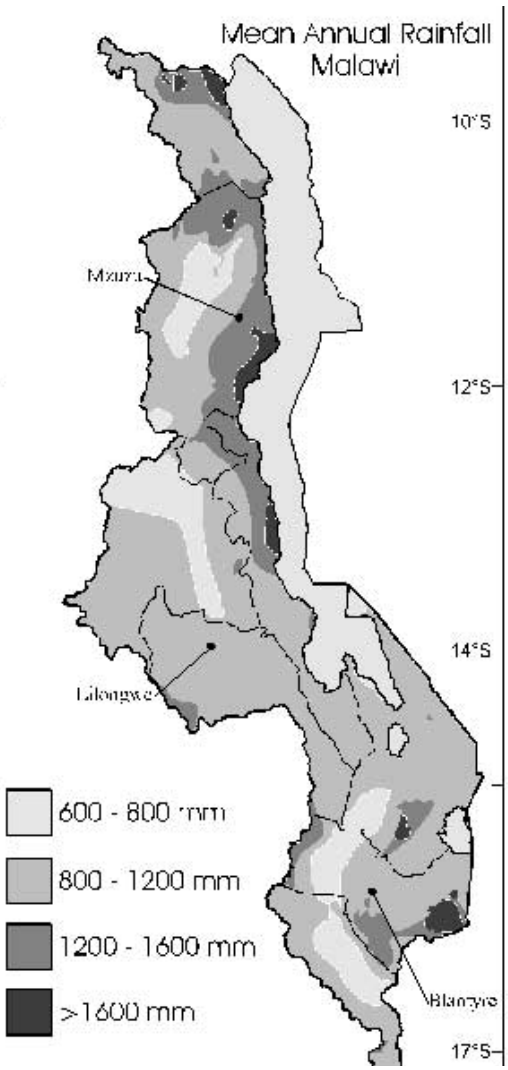

Figure 3. Mean annual rainfall in Malawi
(Source: Moriniere and Chimwaza,1996

The Plateaux: Three quarters of Malawi consists of plateaux at elevations of 750–1 300 m asl. The topography is flat to rolling, with scattered rock inselbergs. The soil is deep well drained latosols on higher parts of the *catena*, with poorly drained sand and clay in the hollows. Poorly drained hollows are locally called *dambos*, (equivalent to *vleis* in Zimbabwe and South Africa).

The Lakeshore and Upper Shire Valley: Lakeshore plains occupy 8% of the total land area, at 465–600 m asl. The land is flat to gently undulating, with deep calcimorphic soils in the hollows. The upper Shire River flows through a broad flat valley from the south of the lake towards the south of the country. Soils are similar to those along the lakeshore. Mopanosols are found in some areas along the river.

Table 4. Mean annual rainfall levels, 1975/76–90/91

Rainfall mm/year	Karonga	Mzuzu	Kasungu	Salima	Lilongwe, Chitedze	Machinga, Liwonde	Blantyre, Chileka	Shire Valley, Ngabu
1975–76	1 184	1 476	379	1 894	1 014	915	729	847
1980–81	887	894	1 031	1 252	905	728	893	745
1985–86	1 026	1 566	1 086	1 479	956	1 248	1 028	911
1990–91	825	1 048	771	1 073	656	736	833	800

Source: NSO, 2000

The Lower Shire Valley: The lower Shire extends from Kapachira falls to Nsanje at the bottom of the country, mostly at less than 180 m asl. The river flows through two marshes with extensive areas of hydromorphic soils. To the east of the river, up to the Thyolo escarpment, soils are medium to coarse textured alluvial and colluvial. To the west there is a broad plain with vertisols and grey brown earths, rising towards the western escarpment. Some areas of saline soils are found.

3. LIVESTOCK PRODUCTION SYSTEMS

Livestock accounts for around 7% of agricultural GDP in Malawi. In 2000 it was noted that the animal population was low with 710 000 Malawi Zebu cattle, 12 000 dairy cattle- Freisian and crosses, 110 000 sheep and 1 260 000 goats. It is worth noting that published animal numbers are nearly always extrapolations, and hence different sources will arrive at different figures depending upon the assumptions made. A picture emerges of relatively static cattle numbers but increasing numbers of smallstock. This is confirmed by the livestock data from the FAO databases shown in Table 5. Pig and poultry stock (not shown) also appear to have changed little in recent years. Only 4% of households have cattle pens, 15% have goat pens and 55% own poultry (free range and layer/broilers). This indicates a marked decrease in cattle ownership since the early 1990s when 13% of farmers were reported to own cattle (Munthali et al, 1993). Livestock are most numerous in the Northern region (Table 6). The three northern Agricultural Development Districts (ADD) - Karonga, Mzuzu and Kasunga - contain almost 80% of the national total of oxen. Over the past 15 years there has been a marked decline in the number of work oxen in the Central and Southern Regions, with increased reliance on hand labour (Kumwenda, 1988; FAO, 2000). Few animals are stall fed; less than 600 were recorded in a recent census for the entire country (reported by NRI, 1998). However, a larger number may be provided with locally produced crop residues to supplement grazing. Nevertheless, the supply of manure from kraals is very limited in relation to the area of cropped land. The maximum cattle density is in the far north, 1.4 cattle/ha cropped land, while over most of the country the density is less than 0.25 cattle/ha cropped land (Figure 4). It can be estimated that over most of Malawi only 1 tonnes of manure is available for every 10–25 ha cropped land (NRI, 1998).

Meat and milk production and per capita supply are shown in Tables 7 and 8. In 2000 there were estimated to be 12 000 dairy cattle in the country, mainly around the urban centres of Blantyre, Lilongwe and Mzuzu (Mpofu, 1998).

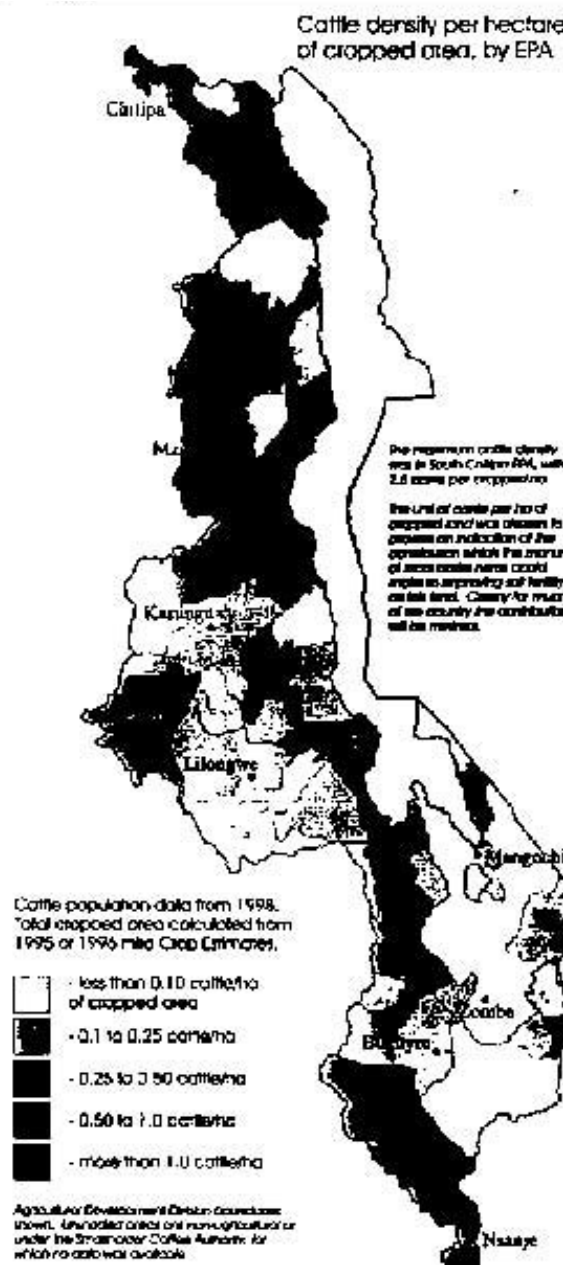

Figure 4. Cattle area per hectare of cropped land
(Source: Moriniere and Chimwaza, 1996)

Table 5. Livestock numbers in Malawi, 1996–2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cattle nos (,000)	700.1	598.2	715.4	711.7	763.7	749.0	750.0	750.0	765.0	750.0
Sheep nos (,000)	93.0	97.9	102.7	103.1	111.5	115.3	115.0	115.0	115.0	115.0
Goat nos (,000,000)	1.26	1.57	1.60	1.43	1.69	1.67	1.70	1.70	1.90	1.90

Source: FAO Database, 2006

Table 6. Distribution of livestock across Malawi in 1998

Livestock (head)	Karonga	Mzuzu	Kasungu	Salima	Lilongwe	Machinga	Blantyre	Shire Valley	Total
Cattle	86 687	130 502	91 501	44 965	73 128	3 876	42 547	81 129	589 175
Work oxen	12 217	29 480	17 147	2 137	9 333	1 977	852	1 584	74 997
Goats	23 700	130 345	264 822	149 930	349 680	217 001	211 666	21 937	1 566 514
Sheep	4 521	14 580	11 913	13 499	9 544	38 391	2 482	2 987	97 916
Poultry	46 340	94 660	106 325	121 395	172 694	271 117	241 631	61 837	1 115 999

Source: NRI, 1998
NB. Note the difference in totals between the NRI and FAO data

Table 7. Meat and milk production in Malawi, 1996–2005*

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Beef and veal (,000 mt)	22.6	12.1	14.3	14.6	16.0	16.0	16.0	16.0	15.7	16.0
Goat meat (,000 mt)	4.5	5.6	5.8	5.1	6.1	6.0	6.0	6.0	6.6	6.6
Mutton and lamb (mt)	322	343	364	364	388	402	402	402	402	402
Cow milk (,000 mt)	32.0	33.0	33.0	34.0	35.0	35.0	35.0	35.0	35.0	35.0

** in addition pigmeat production was estimated at 21 000 mt in 2004 and chicken meat production at 15 280 mt.*
Source: FAO Database 2006.

Table 8. Meat and milk supply per capita per annum in Malawi, 1990 and in 1995–2002

Supply/cap/year (kg)	Year								
	1990	1995	1996	1997	1998	1999	2000	2001	2002
Bovine meat	1.8	1.5	2.2	1.2	1.3	1.3	1.4	1.4	1.4
Goat and sheep meat	0.4	0.3	0.5	0.6	0.6	0.5	0.6	0.6	0.5
Whole milk	5.2	3.7	4.0	4.2	4.0	3.9	3.6	3.6	4.7

Source: FAO Database 2005

Consumption of animal protein is very low in Malawi, even compared to other sub-Saharan African countries, a reflection of the low number of households owning animals, and limited purchasing power of consumers, even in urban areas. Between 1990 and 2002 the amount of bovine meat consumed per capita declined while that of goat and sheep meat remained the same or very slightly increased. Apart from the 2002 figure milk consumption per capita declined. Consumption of pig and poultry meat and eggs remained fairly similar over the period. milk and milk product imports range from 5 000 to 12 000 Mt per year apart from 2002 when 27 000 Mt were imported.

3.1 Smallholder sector

East African Zebu (Malawi zebu), a small slow growing animal, is the dominant cattle breed. In the 1980s Canadian Holstein cattle were imported to stimulate the establishment of a dairy industry. Small East African goats are most numerous with small numbers of Boer and their crosses, and a very small number of crossbreeds, derived from European dairy breeds and indigenous goats.

Almost all ruminant livestock graze on traditional communal lands. During the rainy season, grazing in the Central and some parts of the Southern Region is restricted to dambos and roadsides, or hillside grazing if most of the land is planted to crops. Cattle are herded while goats are tethered by the roadside or around dambos. In the less populated north, cattle are let loose to graze on natural pasture in the uplands areas during the rainy season, and move into dambos during the dry season. When crops have been harvested animals are allowed free access to residues. During the dry season, natural pasture grazing is supplemented with crop residues. There are an estimated 2.7 million ha of available natural grazing in Malawi. Crop residues, from 385 000 ha of cultivated land are grazed in situ, so that some excreta are deposited directly on cropland. Local Zebu cattle may also be offered maize bran as a supplement, but in the absence of cattle, maize bran will be fed to poultry rather than to small ruminants. Stall-fed

dairy animals are offered cut-and-carry roadside grass, supplemented with maize bran and other locally available residues. Around Blantyre these include maize stover, groundnut tops, sweet potato tops, sugar cane tops, rice straw, and banana pseudostems. The area available for grazing increases from south to north in Malawi, reflecting the changes in human population density.

3.2 Estate sector

The estate sector is oriented towards production of tobacco and other cash crops. On tobacco estates a cropping cycle with maize and a grass ley is used to prevent the build-up of nematodes in the soil, and to maintain soil nitrogen at a level appropriate for tobacco. Rhodes grass was often planted on tobacco estates, grazed by herds of beef cattle, which had access to maize stover grazing in the dry season.

What commercial dairy farming that exists is found in the estate sector. Holstein and holstein crosses are grazed and supplemented with concentrate feed. The system is labour intensive, relying on hand milkers. Breeding uses AI, backed up with natural service.

4. PASTURE AND FODDER RESOURCES

4.1 Natural vegetation

Figure 5, which shows vegetation patterns, and much of the material for this section is taken from Rattray (1960) and Moyo *et al.* (1993). DM production of natural grassland is estimated to be 1.0 tonnes/ha/year for the country as a whole (Hodges, 1983). In the north grazing is mainly in forest or regrowth after cultivation. The productivity of edible herbage under bush regrowth is low.

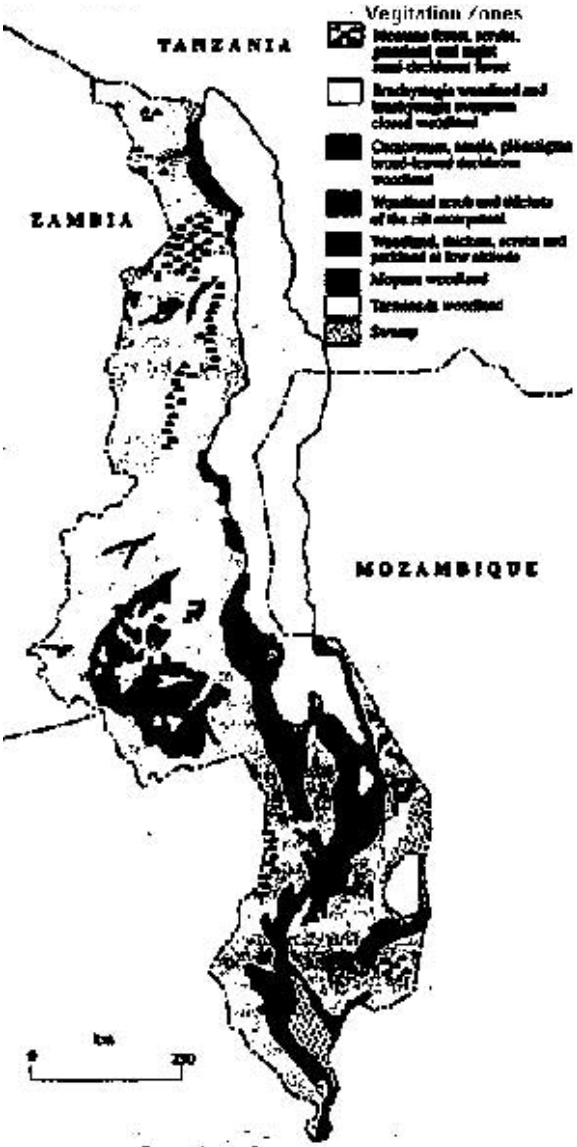

Figure 5: Vegetation resources in Malawi
(Source: Moyo et al. *1993*

Montane forests, scrubs and grasslands: These areas are found above 1 500 m asl, comprising forest relics in valleys and in isolated stands, with rolling grasslands and scrubland between. The pattern seems to be controlled by regular grass fires, and by the moisture of lower lying areas maintaining a greener and more fire-resistant margin to the remaining forest. Rainfall is above 1 500 mm, and is partly composed of a mist formed in the cold dry season, which provides moisture outside the main rainy period. The forests vary in composition and include communities dominated by *Widdringtonia whytei* (mulanje cedar) and *Juniperus procera* (African juniper).

Between 1 500 and 2 100 m asl a variable grassland occurs of short tufted to densely tangled grasses of low ground cover. Species include *Themeda triandra, Exotheca abyssinica, Monocymbium ceresiiforme*, *Elionurus argenteus, Brachiaria serrata, Andropogon schirensis, Hyparrhenia lecomtei* and *Loudetiasimplex*. On wetter slopes and better soils, *Hyparrhenia cymbaria, Rhynchelytrum stolzii, R. nerviglume,*

R. stuposum and *Melinis maitlandii* are also found. Fire tolerant *Protea* species invade this type of grassland and many woody shrubs including *Tephrosia aequilata* and *Humularia descampsii*.

Above 2 000 m asl the grassland is mainly comprised of *Exotheca* species, and produces a short tufted apparently dense ground cover. Species reported in the Malawi montane grasslands include *Exotheca abyssinica*, *Loudetia simplex*, *Trachypogon spicatus*, *Helictotrichon elongatum*, *Agrostis* spp, *Monocymbium ceresiiforme*, and *Elionurus argenteus*. *Festuca schimperiana* is common in the wetter areas, with *Danthonia davyi* in exposed situations. *M. ceresiiforme* occupies only shallow soils in the montane area, whereas a lower altitudes it is confined to swampy grasslands. The nutritional value of montane grassland declines in the cold season.

Brachystegia woodlands (*miombo*): Brachystegia woodland, also known as *miombo* or savannah woodland, is almost ubiquitous, characteristically containing one or more species of *Brachystegia* with *Julbernadia globiflora*. The grass layer is depressed by the relatively light crowned trees, which have the ability to coppice freely after cutting. The woodland varies in density from tall fairly open woodland to dense scrub according to treatment. *Miombo* is generally found between 600–1 500 masl with an annual rainfall of 510 to 1 530 mm. Grass species include *Hyparrhenia filipendula*, *Themeda triandra*, *Andropogon schirensis*, *Bewsia biflora* and *Andropogon amplectens*. On shallow soils, especially in the Northern region *Anthephora acuminata*, *Tristachya inamoena*, *Sacciolepis transbarbuta*, *Rhynchelytrum nyassanum* and *Homozeugos eylesii* are also found.

Grasses vary according to habitat, but are generally of medium height with low ground cover. When trees are cleared the grasses become more vigorous and a dense vegetative cover results until the scrub regrows. The grazing value is low with marked seasonal variation, and the sparse cover has a low carrying capacity. Although the grasses respond to burning and produce a flush of fresh growth after fires, the main reason for managed burning is scrub control.

Shallow, seasonally waterlogged depressions at or near the head of a drainage network are called *dambos* in Malawi. *Dambos* are easily recognized by the sharp contrast between dry typical *miombo* woodland, or cleared agricultural land, and the open herbaceous vegetation on the dambo itself. *Dambos* are nearly treeless areas dominated by grasses or sedges with a build-up of organic matter with a hydromorphic, sometimes peaty upper soil horizon. Botanical composition of plant cover varies from the edges to the central, more waterlogged zone in *dambos* (Table 9). While grasses predominate at the margins, sedges herbs, rushes and ferns are more common nearer the central wetter area. A *dambo* catchment also acts as a hydrological store, holding water and releasing it as base flow to its headwater stream during the dry season. Because they retain water, *dambos* support vigorous growth of grass when other forms of grazing are in short supply. *Dambos* are particularly important in Central and Northern Malawi, and provide a valuable dry season feed resource for ruminant livestock. *Dambo* margins are also used for gardens providing a more reliable crop output than rainfed dryland farms, and spread labour demand more evenly throughout the year. Gardens are fenced to prevent damage by livestock which compete for space in more densely populated areas. Limited grazing in dambos prevent tall grasses such as *Hyparrhenia* from producing seedheads, ensuring continuous growth through most of the dry season (Roberts, 1988). On better soils, such as at Chitedze Research station DM production from *dambo* grasses averaged 5.9 tonnes/year. However, grass DM output can fall as low as 0.2 tonnes/year where poor management has resulted in a dense coppice of *Uapaca kirkiana* such as in West Mzimba. The overall mean DM production in *dambos* is estimated to be 3.2 tonnes/ha/year (Hodges, 1983)

Table 9. Typical non-arboreal plant species in southern African *dambos*

Marginal wash zone	Central seepage zone
Alloteropsis semialata (g)	*Andropogon eucomus* (g)
Aristida sp (g)	*Arundinella nepalensis* (g)
Brachiaria filifolia (g)	*Eragrostis namaquensis* (g)
Hyparrhenia rufa (g)	*Eragrostis stapfii* (g)
Loudetia simplex (g)	*Hyparrhenia bracteata* (g)
Monocymbium ceresiiforme (g)	*Sporobolus subtilis* (g)
Setaria sphacelata (g)	*Cladium mariscus* (s)
Cassia mimosoides (h)	*Scleria hirtella* (s)
Emilia integrifolia (h)	*Dissotis canescens* (h)
Impatiens sp (h)	*Gladiolus* sp (h)
	Typha latifolia (r)

g = grass; s = sedge; h = herb; r = rush; f = fern
Source: Roberts 1988

Broad-leaved deciduous woodland: On red clay loamy soils of the Central region plain, and on colluvial slopes and plains elsewhere in Malawi at altitudes of 600-1200 masl with rainfall of 510 to 1 530 mm a tall grass mixture is found with a broad

leaved deciduous woodland, known as *chipeta*. Varying density of *Acacia polyacantha*, *Piliostigma thonningii* and *Combretum molle* occurs. Selective tree felling has produced communities with a single dominant tree species, while cultivation and overgrazing have produced scrub and thickets. The grass mixture includes *Hyparrhenia variabilis, H.filipendula,H. gazensis, H. nyassae, Setaria sphacelata, S. longiseta, Digitaria setivalva, D. diagonalis, Panicum maximum,* and *Themeda triandra.* These areas are subject to fierce annual burns, and fire tolerance is a typical characteristic of the woody species found. The grazing is of low carrying capacity. Overgrazing of these areas and of the associated swamp grasslands leads to colonisation by *Urochloa pullulans,* a palatable but poor ground cover plant, and then by *Sporobolus pyramidalis,* which produces a tough, unpalatable tufted ground cover.

Rift Valley escarpment and the foothills: These areas, at altitudes of 900 to 1 500 m asl and a wide range of rainfall (350–1 500 mm) are characterised by lowland woodlands with *Brachystegia manga*, *Pterocarpus angolensis*, and on the lower slopes *Sterculia quinqueloba*. On the lower foothills the baobab (*Adansonia digitata*) with an understory of bamboo (*Oxytenanthera abyssinica*) are frequent. The grasses comprise *Hyparrhenia gracilescens*, *H filipendula*, *Themeda triandra*,*Andropogon amplectens*, *Schmidtia bulbosa*, *Euclasta condylotricha*, *Eustachys paspaloides*, *Eragrostis superba*, and *Thyrsia undulatifolia*. Grasses form a low ground cover on broken, stony soils. These areas have limited grazing value because of the difficult terrain and lack of dry season pasturage.

Low altitude woodland and parkland: Low altitude woodland and parkland are found below 600 m asl and include areas in the Shire Valley and along the lakeshore. Soils are influenced by drift and colluviation, and rainfall may vary sharply within short distances (350 mm to 2 500 mm in one area alone). As a result a wide floristic range can be found. Tall grasses are associated with low altitude woodland, including *Hyparrhenia gazensis, H. variabilis, H. dichroa. Andropogon gayanus, Setaria palustris, and Panicum maximum.* In densely settled and cultivated locations, tall reedy grasses are replaced by *Urochloa pullulans* and *U. mosambicensis*. Woodlands are characterised by *Sterculia africana*, *Colophospermum mopane*, *Acacia tortilis* and *Faidherbia albida* according to locality. *Acacia* woodland provides valuable grazing from pods to supplement grasses in the dry season. Mature trees may stand within a dense understorey, which includes *Commiphora* spp, *Bauhinia tomentosa*, and *Popowia obovata*. The understorey is likely to be man-induced since lone-standing mature trees are found elsewhere in open areas of cultivated land, and in some cases trees are selectively retained by farmers to maturity (eg *Faidherbia albida*). In some areas, woodlands and thickets may be dominated by *Mimosacea*e. *Terminalia sericea* woodlands form on sandy soils, with *Pterocarpus antunesii*, *Fagara* spp and *Grewia* spp woodland and thickets around the Lower Shire river. Base rich soils support *Euphorbia ingens* and *Commiphora* thicket, whilst *Hyphaene ventricosa, H. crinita* and *Borassus aethiopium* palms occur where the water table is high.

Becker and Lohrmann (1992) studied small East African goats at a Salima lakeshore site. Green vegetation covered 79% of the site in the wet season, with 40% cover from dry material in the dry season. In the wet season equal time was spent feeding on grass and browse, whereas in the dry season 93% of time was spent feeding on dry browse. *Andropogon schirensis* was the most common grass species, with *Markhamia acuminata, Bauhinia petersiana, Combretum fragans* and *Friesodielsia obovata* the most common browse. Grass palatability decreased markedly from wet to dry season, but browse palatability remained unchanged. Thorny acacias (*A. polyacantha, A. nilotica* and *A. nigrescens*) were very palatable. The leaves of *Friesodielsia obovata*, and *Combretum apiculatum* remained palatable, while the blossoms of *Cordyla africana* and *Lonchocarpus bussei* and fruits of *A. polyacantha* were highly accepted.On wetter areas of vertisols under natural pasture, a vigorous growth of *Ischaemum brachyatherum* holds surface soil together with a dense mat of rhizomes, slowing and diffusing the run-off of water (Mitchell, 1987).

Swampland: Edges of swamps and lakes are fringed with the sedges and grasses including *Cyperus papyrus*, *Echinochloa pyramidalis*, *Typha australis*, *Vossia cuspidata* and *Pennisetum purpureum*.

4.2 Cultivated legumes and fodders

Introduction and evaluation of germplasm in the 1960s and 1970s was undertaken mainly to seek alternatives to Rhodes grass (*Chloris gayana*), the established commercial species widely used on tobacco estates to suppress nematode population as well as providing fodder for beef cattle. From these screenings, a number of species and cultivars from the genera *Panicum, Chloris, Cynodon* and *Cenchrus* were shown to have good forage potential. Over the same period the increasing cost of inorganic N fertilisers promoted a search for a cheap source of biologically fixed N from herbaceous legumes, including the genera *Stylosanthes, Macroptilium, Macrotyloma, Neonotonia, Centrosema,* and *Desmodium* (Thomas, 1976). At that time, there was a dual focus on identification of forages for stallfeeding operations as well as for grazing. *Pennisetum purpureum* v. Gold Coast and *Panicum maximum* v. Ntchisi Panic were recommended for cut and carry systems which were being promoted around Lilongwe Agricultural Development District in the Central region (Dzowela, 1985; Munthali and Dzowela, 1987).

Buffel grass (*Cenchrus ciliaris*) had been shown to be more productive than Rhodes grass (Anon, 1975) in terms of DM and CP productivity. Furthermore, buffel grass produced viable seed unlike alternative species such as *Panicum coloratum*, cv Bushmans mine and *Cynodon nlemfuensis*. Studies were made of the suitability of different varieties of buffel grass, and buffel/ legume combinations at contrasting sites in different agro-ecological zones, with Chitala representative of a Lakeshore/Shire Valley environment, and Chitedze of the medium altitude plateaux, and appropriate varieties were identified.

Hodges (1983) in the Pasture Handbook for Malawi recommended different forages and combinations of forages for grazing, hay or cut-and-carry feeding in different environments across the country.

Many grass and legume varieties that showed promise in Malawi had already been tested and introduced in Zimbabwe. Work in the 1970s for a grass that would persist under grazing identified *Cynodon nlemfuensis* cv Henderson No 2, which was able to support grazing through wet and dry seasons better than Rhodes grass (Anon, 1975). *Chloris gayana* and *Desmodium uncinatum* cv Silverleaf were shown to be compatible, and that translated into higher animal weight gains in comparison to Star grass pastures, even though the latter supported increased grazing days (Dzowela, 1985).

Various attempts were made to introduce legumes into natural pasture. A UNDP/FAO project in the mid-1970s demonstrated that *S. guanensis* cv Cook improved dry season liveweight gains for grazing cattle at West Mzimba. Similar benefits where shown by the inclusion of stylo in natural pasture at Dzalanyama Ranch in the Central Region. Seed was sown in strips ploughed through natural pasture, after which dispersal was obtained by the passage of ingested seed through grazing animals. However, the benefits proved transitory as it was impossible to maintain an adequate proportion of legume in the pasture under communal grazing management.

During the 1990s increased attention was paid to tree legumes, focusing largely on *Leucaena leucocephala* and *Faidherbia albida,* mainly for soil fertility and crop production (Saka *et al,* 1991). Despite a considerable number of smallscale research and development projects, few have led to farmer adoption of agroforestry practices. The most promising appears to be the use of *F. albida* as well spaced trees in cropland, a traditional practice with naturally occurring specimens in Salima District. In addition to the benefits accruing from leaf fall to soil fertility and crops yields (and hence crop residues) under the tree canopy, livestock graze on fallen seeds which are highly nutritious. Leucaena had previous been promoted in the mid-1970s by a cattle stall fattening and dairy project (Addy and Thomas, 1976; Savory and Breen, 1979), but interest faded after the end of the project. The merits and demerits of agroforestry for improved livestock production were commented upon by Munthali (1991). Smallholder dairy development work during the late 1980s and 1990s in the milk shed areas of Mzuzu, Lilongwe and Blantyre stimulated further interest in cut and carry forage. Farmers, however, still made greater use of natural pasture from dambos and roadside grasses, in preference to cultivated forages.

4.3 Crop residues

A total of 1.2–1.5 million tonnes of maize stover is available in each dry season to supplement natural grazing. Smallholder farmers form stooks of cut maize to finish drying in the field, before removing the cobs later. This produces a number of stover heaps around the field. Virtually all of the stover is grazed

in situ, so that possibly half is trampled and soiled. The contribution of maize stover varies markedly around the country. The maize area/head of cattle varies from <0.3 ha/head in Karonga District in the far north to 45 ha/head in Machinga District. Legume residues, especially groundnut haulms, may be collected and brought back to the household for storage and more efficient use by cattle. Few households own cattle, and little attention is paid to the provision of supplementary feed for small ruminants. Any DM remaining in the field (weeds, crop residue trash) is burnt prior to land preparation for the next season.

In the southern region, plantings of *Cajanus cajan* and *Manihot* spp. have increased over recent years. Although there are relatively few cattle, the presence of a long season crop in the field requires protection from free grazing animals. Benefits to soil fertility of incorporation of crop residues depends on C: N ratio in the residue. In the short term, the incorporation of low N material adversely affects fertility through utilisation of free N in soil for bacterial growth. However, high N residue is the most valuable for animal feed. For most smallholder farmers in Malawi, soil fertility (and hence crop yield) is more important than animal feed. This will only change when a market develops for the sale of animal feed, which will probably be dependent upon consumer demand for meat and milk and their ability to pay farmers an attractive price for livestock products.

4.4 Constraints to pasture and fodder production and improvement

By the end of the 1980s, over 56% of farmers had less than 1.0ha with a further 20% between 1.0 and 1.5 ha. The small size of farms constrains farmers from growing pasture crops when they have difficulty meeting household food needs. It is estimated in an average year that some 60% of households run out of food produced from their own farms three months before the next harvest (MALD, 1995). Forage cultivation has been promoted for smallholder fattening and dairy projects, with mixed success.

Free access to harvested fields in the dry season limits the opportunity for undersowing or the use of palatable agroforestry species.

Pasture/fodder crop seeds are difficult for smallholder farmers to obtain, even if they have the money to buy.

Although extension staff receive training in both crop and livestock production, the emphasis in extension is placed on food crops. Staff have very limited knowledge of pasture/forage crops.

Technical problems, such as lack of information and seed, are only part of the problem. Smallholder investment in livestock has been depressed by poverty, low demand for livestock products, and the possibility of animal theft. The incidence of theft has become more prevalent with the advent of a freer political climate. Inadequate nutrition has contributed to poor health of rural workers, exacerbating the difficulties faced by households suffering from HIV/AIDS. Education and information dissemination is currently and will be increasingly hampered by staffing problems. A World Bank assessment of AIDS in Malawi has estimated that 40% of employees in specific sectors, including education and health, would die from AIDS by the year 2005 (Cohen, 1999). Labour and capital saving technologies for smallholder farmers, taking into account the specific needs of HIV/AIDS affected households, are likely to be viewed as high priority in future. It may be in the future that cut-and-carry feeding of a few animals, rather than herding has a role to play here, with a resultant demand for cultivated forages.

5. PASTURE SEED PRODUCTION

Pasture seed production has not developed in Malawi, partly as a result of lack of demand. Nevertheless, studies in the 1970s demonstrated the environments where grass and legume production was satisfactory under rainfed conditions (Hodges, 1983). Seed harvesting techniques, suitable for village conditions, were explained, and seed application rates were also shown. Despite this, the provision of forage seed has usually depended on inputs from externally funded projects.

6. RESEARCH AND DEVELOPMENT

6. 1. Institutional structure

Agricultural research in Malawi is directed towards applied or production oriented research to generate information and technologies which can be directly utilised by smallholders to solve technical production problems, with goals of improving incomes and distribution of income, diversification of production and stabilising or improving natural resource levels.

The Agricultural Research Department (DAR) of MoA is mandated to undertake research on a wide variety of crops and Livestock. Research on high value export commodities such as tea, tobacco and sugar is carried out by other specialised institutions. DAR has research stations in each district of the country, with 11 research stations, and 20 sub-stations. Chitedze Research Station, near Lilongwe is the centre for pasture and forage work. MoA has mandated the University of Malawi to conduct specific disciplinary research. Bunda College of Agriculture carries out research into beans, rabbits, pigs and socio-economics. Chancellor College works with DAR on cassava pests, soil pests and cassava detoxification. The Department of Animal Health and Industry carries out research on poultry and goat breeding. Contract research funding is also provided by GM, to other organisations for research activities where DAR does not have sufficient resources. External funding for research may go through GoM or direct to the implementing agency. Details of research intentions are laid out in Agricultural Research Masterplan and Action Plans (MALD, 1993).

International research centres are represented by ICRISAT, based on Chitedze Research Station, and ICRAF at Makoka Research Station. Other autonomous agricultural research and development projects include Malawi Agroforestry Extension Project funded by USAID, and Promotion of Soil Conservation and Rural Production funded by the EU. There is currently no externally funded work focused around livestock, fodder, pastures or herbaceous legumes.

NGO projects are focused on crop production and means to stabilise and improve food security. Other areas of priority for NGO attention are education and health.

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