Country Pasture/Forage Resource Profiles

NAMIBIA

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1. INTRODUCTION

Namibia (formerly South West Africa) is situated in the south west of the continent of Africa, bordered by the Atlantic Ocean on the west, Angola and Zambia to the north, Botswana to the east and the Republic of South Africa to the south (Figure 1). The total land area is 824 269 km^2.

With a mean annual rainfall of approximately 270 mm, Namibia is rated to have the driest climate in sub-Saharan Africa. The only perennial rivers flow along parts of the northern and southern borders, and the country is almost entirely dependent upon ephemeral rivers and groundwater.

In 2000 Namibia's population was estimated at 1.7 million (according to the World Factbook the July 2006 population was estimated at 2 044 147 with a growth rate of 0.59%), of which approximately 73% was rural and 27% urban. Agriculture accounts for 9% of GDP and 14% of exports and supports, directly or indirectly, 70% of the population (IFAD, 1997).

Figure 1 Location of Namibia

There are three broad categories of land tenure in Namibia. Approximately 44% of the country is so-called "commercial" farmland with freehold tenure, 41% is allocated to communal areas, and the remaining 15% is state land including conservation areas. The communal areas are situated mainly in contiguous blocks in the north of the country, while the commercial (freehold) areas occupy most of the centre and the south of the country.

2. CLIMATE, LANDFORMS AND SOILS

Aridity and varied topography provide the physical backdrop for Namibia's natural resource base. In geological time several phases of uplifting, erosion and deposition have created complex landforms determined by the underlying geology.

2.1. Climate and drought

There is wide regional variation in annual rainfall, from less than 20 mm in the western Namib and coastal zones to more than 700 mm at the eastern end of the Caprivi strip, but only 5% of the country receives more than 500 mm (Table 1).

In the major part of the country there is a single wet season in summer and the bulk of the rain falls between the months of November and March. Annual rainfall distribution is skewed such that there are more below average than above average rainfall years, and the median is more meaningful than the mean. The high seasonal variations are accompanied by high spatial variability, and the annual potential evapo-transpiration exceeds annual precipitation by ratios of up to 30:1 (not counting the desert areas), hence drought conditions are a common phenomenon throughout most of the country (Sweet, 1999). The very south-west of the country receives winter rainfall associated with frontal systems and there is a broad transitional area receiving winter and/or summer rains.

Table 1. Annual rainfall distribution and climatic classification in Namibia

Rainfall (mm)	Classification	Percentage of land surface
<100	Desert	22
101-300	Arid	33
301-500	Semi-arid	37
501-700	Sub-humid	8

Source: National Drought Task Force, 1997a

2.2 Landforms and agro-ecological zones

The country comprises three main physiographic regions. The first is the western coastal plain of the Namib desert, occupying 12% of the total, the second is the central plateau stretching from the southern to the northern border and covering more than half the country, and the third is the semi-arid Kalahari zone lying along most of the eastern portion of the country (Isaacson, 1995).

The western coastal plains are largely composed of mobile dunes and gravel and sandy plains. The central plateau comprises mountains, highland areas and the Great Western Escarpment. The Kalahari zone is covered by sand of varying thickness.

Based on landforms and growing periods, eight major agro-ecological zones have been differentiated in Namibia. In addition, there are locally important river canyons and undifferentiated rocky hills (de Pauw *et al.* 1998). The major zones are:

- Central plateau
- Damaraland landscapes
- Ekuma plains and Etosha pan
- Escarpment
- Kalahari sands plateau
- Kalkveld
- Kaokoland landscapes
- Namib sand seas and desert plains.

In line with the decreasing rainfall from north-east to west and south, growing periods range from 120 days in the Caprivi (north-east) to no growing period in the desert areas. Except for the north-east and central northern areas, the agricultural potential of Namibia is thus restricted to livestock farming.

2.3 Soils

Unconsolidated sand (arenosols) and shallow, weakly developed soils on bedrock (lithosols, xerosols, regosols and yermosols) characterize the main groups of soils in this semi-arid to arid country (FAO, 1973).

Some 97% of the country's soils have a clay content of less than 5%, and thus have a very low water holding capacity. They are generally deficient in most of the major nutrients, and also deficient in micro-nutrients such as manganese, iron and zinc. Salinity is a significant factor in and around the Etosha pan. Considering soils and rainfall, only about 1% of the land surface, or 820 000 ha, is considered to have medium to high potential for rainfed and irrigated crop production (NDTF, 1997a), and the bulk of this occurs within the communal areas in the north-east of the country.

3. LIVESTOCK PRODUCTION SYSTEMS

In 2001/2002 there were about 2.5 million cattle, 2.9 million sheep and 2.1 million goats in the country, in addition to smaller numbers of asses, mules, pigs, poultry and farmed ostriches. However, the numbers of cattle and small stock fluctuate considerably in response to high and low rainfall years. The 1998 census data showing distribution between the freehold and communal sectors are shown in Table 2. Beef production is the most important livestock related activity, followed by small stock (sheep and goat) production, and most of the output from the livestock sector is exported. There is also a production of 4 400 tonnes of game meat mainly for local consumption. The combined livestock sector contributes 75% of total agricultural output (Directorate of Planning, 1999). Table 3 shows livestock numbers and production for the period 1995–2005. As well as the export of beef and veal (table 3), quantities of mutton and lamb are exported (4-6,000 tonnes per year) and poultry meat is imported (nearly 12 000 tonnes in 2003). Although live cattle exports have declined since the 1990s, live goat exports have increased and live sheep exports have ranged between 0.6–1.0 M head per year since 1995.

Table 2. National livestock census 1998

Tenure	Cattle	Sheep	Goats	Pigs	Poultry	Ostriches
Freehold	824 207	1 727 210	479 930	9 035		51 464
Communal	1 368 152	359 224	1 230 260	5 671		929
TOTAL	2 192 359	2 086 434	1 710 190	14 706	403 937	52 393

Source: Directorate of Planning, 1999

Table 3. Namibia statistics for livestock numbers, meat and milk production, beef and veal and live animal exports and milk imports for the period 1996-2005

Item	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cattle nos. (,000,000)	2.0	2.1	2.2	2.3	2.5	2.5	2.3	2.7	2.9	3.1
Sheep nos. (,000,000)	2.2	2.4	2.1	2.2	2.5	2.4	2.9	2.8	2.7	2.7
Goat nos. (,000,000)	1.8	1.8	1.7	1.7	1.9	1.8	2.1	2.1	2.1	2.0
Beef and veal prod. (,000 mt)	45.8	29.8	38.3	44.6	63.8	57.8	60.9	78.4	81.9	89.0
Sheep meat prod. (,000 mt)	4.2	4.6	1.7	3.6	5.0	8.0	12.6	12.1	11.7	11.3
Goat meat prod. (,000 mt)	4.6	4.8	4.1	4.6	4.7	4.2	4.9	5.0	4.9	4.9
Cow milk prod. (,000 mt)	71.0	74.0	79.0	82.5	88.5	92.0	105.0	109.0	109.0	109.0
Live cattle exports nos. (,000)	279.1	52.4	165.1	152.4	23.7	57.2	47.2	45.0	45.0	n.r.
Live goat exports nos. (,000)	0	121.1	267.5	8.4	29.0	180.3	121.6	127.7	120.0	n.r.
Live sheep exports nos. (,000)	845.0	448.7	1 370.7	224.6	239.8	593.0	638.4	647.1	650.0	n.r.
Beef and veal exports (,000 mt)	28.5	27.2	32.1	22.6	22.3	18.6	16.8	66.0	10.4	n.r.
Milk equivalent imports (,000 mt)	0	24.9	47.6	33.4	36.6	46.6	23.5	26.9	3.6	n.r.

Source: FAO database 2006 n.r. = no record

Domestic milk production is insufficient to meet the needs and in excess of 25 000 tonnes of milk equivalents are imported annually.

Namibia also possesses a rich and diverse wildlife resource, and about 13% of the country is designated as National Parks, but a considerable proportion of the wildlife exists outside formally proclaimed conservation areas. Many commercial farms derive some or all of their income from hunting and/or tourism, and there is an increasing movement towards the establishment of nature conservancy's in communal areas to enable local communities to benefit from their wildlife populations.

There are two widely disparate types of production system. In the freehold farms there are clear boundaries, exclusive rights for the individual properties, and commercial objectives. Land tenure issues considerably hamper the introduction and adoption of improved management practices in the communal areas, where there are often unclear boundaries, there are generally open access rights to grazing areas, and the farmers are subsistence oriented.

3.1 Freehold/commercial sector

The commercial farming sector is well developed, capital-intensive and export oriented. Commercial area livestock production accounts for 69% of national agricultural output (Directorate of Planning, 1999) and comes from 52% of the farming/grazing land. The freehold area is divided into 6 337 farms (1992 data), with an average size of 5 700 ha, owned by about 4 200 individuals or agricultural enterprises.

Cattle are predominant in the northern parts of the country where the rangelands generally have a higher carrying capacity. Beef cattle ranching is the largest contributor to commercial farming income, and the major breeds are Brahman, Afrikaner and Simmentaler. Sheep are largely concentrated in the drier south and are mostly the Karakul, bred mainly for its pelt, and the Dorper for meat production. Goats are more widely distributed and the main breeds are the Boergoat and the Angora. Grazing livestock are raised under extensive ranching conditions, relying on natural pasture occasionally supplemented by protein/mineral licks. Ostriches are farmed in the drier parts of the country and also utilize natural vegetation, supplemented by fodders and concentrates.

The commercial areas are divided into fenced ranches, further subdivided into a number of paddocks, through which some form of rotational grazing is normally practised. Compared to the communal areas, stocking rates tend to be more conservative but fire has generally been excluded, cutting for fuel or building has been minimal, there are fewer browsing animals and there is less mobility in response to rainfall spatial variation. Consequently, large areas of the medium to higher rainfall savannahs have become severely bush infested, to the detriment of the grazing potential for cattle and sheep. In response, there has been a marked increase in game farming and wildlife tourism in the commercial areas, in recognition of the difficulties and consequences of farming with mono-specific (grazer) domestic stock.

3.2 Communal/traditional sector

The communal areas occupy about 48% of the total farming area of Namibia and hold approximately 62% of the total cattle population, 72% of the goats and 17% of the sheep (see Table 2). They differ markedly from the freehold areas in their production systems, objectives and property rights; only the

cropping areas are normally allocated to individual households, while the grazing areas tend to be shared by members of a community. The communal areas also encompass a wide range of environmental conditions and ethnic groups.

The production systems in the communal areas are based on pastoralism and agro-pastoralism, and the majority of households are subsistence-based and labour intensive, with limited use of technology and external inputs. The outputs and objectives of livestock ownership are much more diverse than in commercial livestock production and include draft power, milk, dung, meat, cash income and capital storage as well as socio-cultural factors. Production per hectare is more important than production per head, and the communal area livestock owner's combination of objectives tends to be met by a policy of herd maximization rather than turnover, hence even the large herd owners tend to sell only to meet cash needs.

Communal area livestock production contributes 5–6% of total agricultural output (Directorate of Planning, 1999) and is mainly confined to the northern part of the country. However herd sizes vary considerably between and within regions, and livestock ownership is strongly skewed, with a small number of people owning large herds and the majority owning few animals or none at all.

Stock numbers tend to be less evenly distributed in communal than in commercial areas. There is a tendency for high concentrations of people and livestock near to permanent water, while other areas remain potentially under-utilized due to a lack of water. Animal numbers tend to be geared more to the quantity of reliable water than to the reliable quantity of forage, hence drought effects tend to be more severe in communal than in commercial areas (Sweet, 1999).

Mixed livestock ownership is more common in communal than freehold areas. Cattle are the generally preferred livestock species, and are important for draft power, but economic and ecological conditions often limit the possibilities of cattle ownership. In the south and west-central areas smallstock predominate; in the eastern and northern areas cattle are important, and only in the north-central and north-east regions there is sufficient rainfall for rainfed cropping. Goats and, to a lesser extent, sheep are widely distributed in the communal areas and are mainly indigenous breeds. The pigs and poultry in the communal areas are also indigenous breeds, and the indigenous Sanga is the dominant breed of cattle.

Cattle, sheep and goats are herded during the cropping season in cropping areas, and where there are predator or theft risks in other areas, but herding tends to be relaxed during the dry season during which animals have access to crop residues. In the northern communal areas, many larger herd owners have "cattle posts" away from the village and crop lands, and maintain most of their animals there, keeping only the milk and draft animals at the village during the wet season. Pigs and poultry in the communal areas are generally free-ranging and scavenging, although some owners practise housing and feeding.

4. PASTURE AND FODDER RESOURCES

The main forage resource for livestock in Namibia is rangeland grazing. In the higher rainfall zones crop residues are a very important feed supplement in the communal areas during the dry season when range grazing is scarce, while in the commercial areas some farmers plant fodder species. Irrigated fodder production is very limited owing to the lack of suitable soils and water supplies in the commercial areas. In times of drought, Namibia imports fodder from neighbouring countries.

4.1 Range grazing

The principal vegetation types of Namibia are illustrated in Figure 2. According to this classification (Giess, 1971), the fifteen vegetation types can be grouped into three main vegetation regions. Savannahs occupy 64% of the land area, desert vegetation 16% and dry woodlands 20% of the country. Owing to the relative scarcity of grasses in most vegetation types, browse forms an essential component of the diet for all domestic stock.

Desert vegetation

The Namib desert stretches in a band along the coast, and vegetative cover increases with rainfall away from the coast. The dunes of the northern Namib and the plains of the central Namib are largely bare,

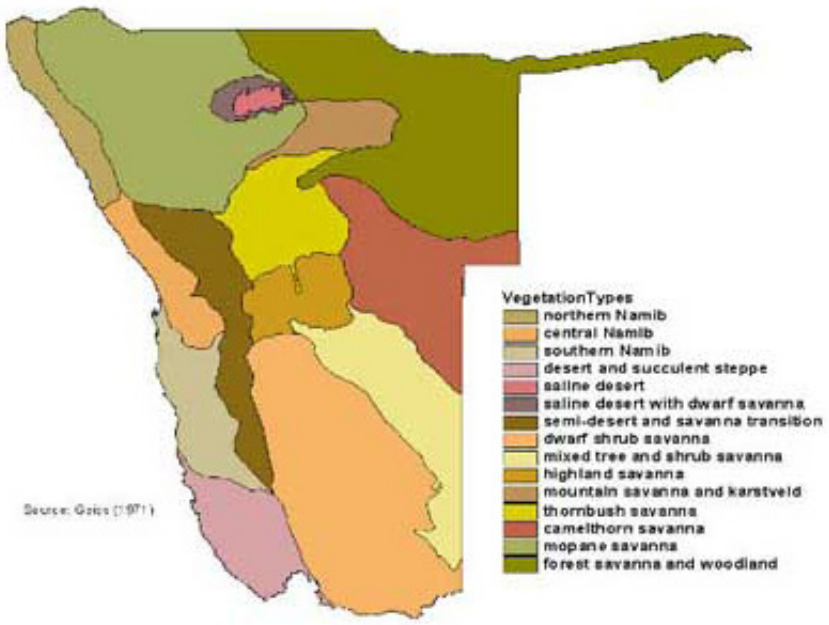

Figure 2 Vegetation types of Namibia

but support scattered annual grasses (*Sporobolus* and *Stipagrostis* spp. after rain). In the southern Namib dune sea, the areas between the dunes become carpeted with *Stipagrostis gonatostachys* after rain. The southernmost part of the Namib is composed of gravel and sandy plains, interspersed with isolated mountains (inselbergs) towards the escarpment. The vegetation is described as succulent steppe and characterized by a dominance of leaf-succulents, such as several *Brownanthus* and *Ruschia* species. The eastern plains of the Namib, known as the pro-Namib become covered with dense stands of perennial grasses such as *Stipagrostis obtusa* and *S. ciliata* after the sporadic rains (Muller, 1984). In the main, these desert areas (<50 mm annual rainfall) support too little vegetation to be useful for any form of livestock grazing.

In the north-central part of Namibia (rainfall >400 mm) is the Etosha pan which is a saline desert with a dwarf shrub savannah fringe composed of *Leucosphaera bainesii, Monechma genistifolia, Petalidium engleranum, Salsola etoshensis* and other shrubs providing valuable browse. The grass cover consists mainly of *Sporobolus* and *Eragrostis* species. This area forms part of the Etosha National park and supports a diverse and abundant wildlife population.

Savannahs

The savannahs can be divided into three main veld (range) types, namely the dwarf shrub savannah in the central-south, the various acacia-based tree and shrub savannah associations in the centre and eastern parts, and the mopane savannah in the north-west.

The dwarf shrub savannah (mainly <200 mm rainfall) is characterized by *Rhigozum trichotomum, Catophractes alexandrii, Eriocephalus* species and various small Karoo bushes. The unpalatable *Euphorbia gregaria* covers large areas of the southern dwarf shrub savannah. The most common grasses are *Stipagrostis* species (*S. uniplumis, S. brevifolia, S. obtusa* and *S. anomala*) but vary with soil types and can include valuable species such as *Panicum arbusculum, Setaria appendiculata, Antephora pubescens* and *Digitaria eriantha*. The dwarf shrub savannah is mainly used for sheep and goat farming.

There are a number of tree and shrub savannah associations in the central and east-central parts of the country. With exception of the Mixed Tree and Shrub Savannah, which is more suited to sheep, the savannah associations are suited to cattle farming (Bester, unpublished data). The mixed tree and shrub savannah of the southern Kalahari is characterized by deep sand and *Acacia haematoxylon*, with various species of *Acacia* and *Boscia* on the harder ground between the parallel dunes. Perennial grasses include *Centropodia glauca, Antephora pubescens, Eragrostis lehmanniana, Stipagrostis uniplumis* and *S. ciliata*, with the annual *Schmidtia kalahariensis* dominating in disturbed veld. This savannah, like the dwarf shrub savannah to the west, is used for sheep farming.

The camelthorn savannah (300–400 mm rainfall) of the central Kalahari is an open savannah with *Acacia erioloba* as the dominant tree. Common shrubs include *Acacia hebeclada, Ziziphus mucronata, Tarconanthus camphoratus, Grewia flava, Ozoroa paniculosa* and *Rhus ciliata*. There is a good grass cover but of coarse, unpalatable grasses such as *Eragrostis pallens* and *Aristida stipitata. Schmidtia kalahariensis* is an indicator of veld deterioration.

The thornbush savannah (400–500 mm rainfall) is the dominant vegetation type in the central part of the country. Bush encroachment by *Acacia mellifera* and *Dichrostachys cinerea* is widely problematic. Other characteristic species include *Acacia reficiens, A. erubescens* and *A. fleckii*. Common grasses include *Antephora pubescens, Brachiaria nigropedata, Digitaria spp., Stipagrostis uniplumis* and *Schmidtia pappophoroides*

The highland savannah (300–400 mm rainfall), situated south of the thornbush savannah, is characterized by trees such as *Combretum apiculatum, Acacia hereroensis, A reficiens* and *A. erubescens*. The grass cover includes *Antephora pubescens, Brachiaria nigropedata, Digitaria eriantha* and other good fodder species.

The mountain savannah (500–600 mm rainfall), found north of the thornbush savannah, has less *Acacia* and is characterized by trees such as *Kirkia acuminata, Berchemia discolor, Pachypodium lealii* and *Croton* spp. Grasses include the valuable fodder species *Brachiaria serrata, Digitaria seriata* and *Panicum maximum*. The annual *Danthoniopsis dinteri* is characteristic of the vegetation type. A complex of this region is the Karstveld (areas with recent surface limestone deposits and shallow soil) which supports *Combretum imberbe, Dichrostachys cinerea* and *Terminalia prunioides*.

The mopane savannah is a distinct vegetation type dominated by *Colophospermum mopane*, which occurs in tree and shrub forms, in the north-west of the country. It spans a wide rainfall range from 50–500 mm rainfall and is suited to both cattle and smallstock farming. In the lower rainfall western areas, the grasses are mainly annuals such as *Stipagrostis hirtigluma, Schmidtia kalahariensis* and *Entoplocamia aristulata*; in the higher rainfall eastern parts there are perennial grasses including *Stipagrostis uniplumis, Schmidtia pappophoroides, Digitaria spp*. and *Antephora pubescens*.

The escarpment area has been characterized as a semi-desert savannah transition zone characterized by a mix of savannah and desert species. While *Acacia* species are dominant in many parts, various stem-succulents such as *Commiphora* and *Cyphostemma* species occur. Various *Stipagrostis* species form the most important grass component.

Dry woodlands

The dry woodlands of the north-east are in the highest rainfall part of the country (500-700 mm) and merge from the tree savannah of the north-central area. They are characterized by *Baikea plurijugia*, *Burkea africana, Guibourtia coleosperma* and *Pterocarpus angolensis.* The grasses tend to be coarse and unpalatable species including *Eragrostis pallens, Sporobolus* spp., *Aristida* spp. and *Pogonarthria squarrosa*, however more palatable ones including various *Brachiaria, Digitaria and Eragrostis* species also occur. This area is considered best suited to cattle (Bester, unpublished data) but goats are also widely owned by the communal area farmers.

It is well recognized that rainfall is the primary determinant of forage production, and a number of workers in Africa have demonstrated linear relationships between annual rainfall and primary production within the rainfall limits experienced in Namibia. These relationships can be simplified to straightforward expressions of kilograms of annual dry matter production of forage per millimetre of annual rainfall (Le Houerou, 1984).

Sweet (1998a) developed a rainfall-related carrying capacity model for Namibia based on an average production of 3.0 kg of aerial phytomass dry matter per hectare per millimetre of dependable (70% probability) annual rainfall. The model produced separate estimates for commercial and subsistence livestock production, with the latter allowing for a higher percentage utilization of forage biomass. The resultant carrying capacity map for commercial production is shown in Figure 3. The model also includes a number of correction factors to be applied according to local site conditions.

4.2 Legume and fodder introduction

A number of sub-tropical pasture legumes and fodder plants have been screened at various sites from 100–700 mm annual rainfall across the northern communal areas, and range re-enforcement has been

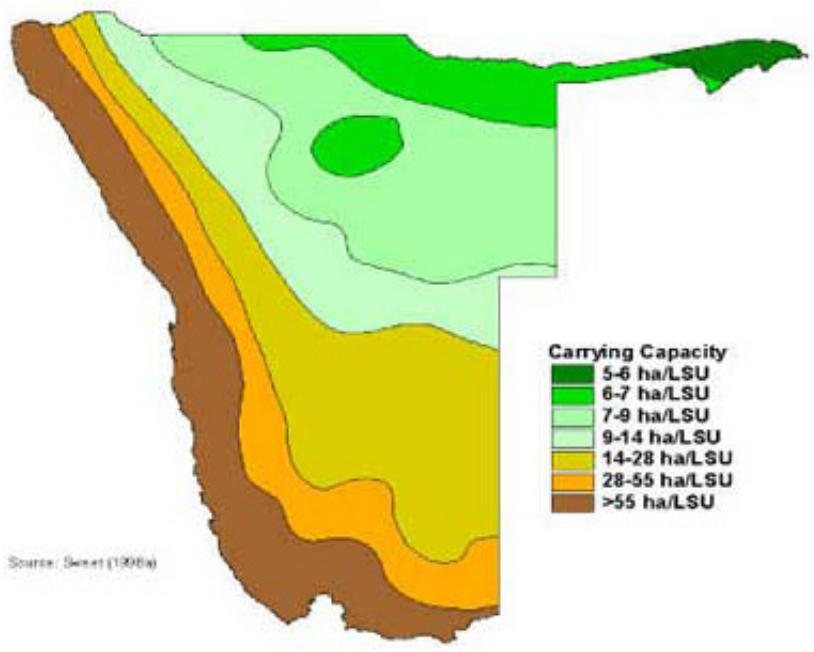

Figure 3 Carrying capacity map for commercial production in Namibia

conducted experimentally on a limited scale. However, most of the country has rainfall that is too low or erratic for reasonable chance of successful establishment.

The implementation and results of a 3 year adaptive research programme in the northern communal areas have been described in some detail by Sweet (1998b). The report includes recommendations of procedures and species for range reinforcement in upland and seasonally inundated areas, undersowing cereals with legumes, alley cropping, establishing fodder banks, and live fencing. However, there has been little farmer uptake except where assistance and/or incentives have been given. The more successful of the screened and tested introductions are listed in Table 4 with their potential uses. The original report should be consulted for regional differences in suitability.

In southern Namibia test trials with sisal (*Agave americana*) and prickly pears (*Opuntia ficus-indica*) as live fences and windbreaks have been carried out (Van Eck *et al*. 1998a). Saline water is a problem in many areas in the south, and recent projects have investigated salt-tolerant exotic and indigenous species for this purpose (Engelbrecht 1997; Van Eck *et al*. 1998b).

However, further screening is intended to focus on indigenous species to avoid potential invasions of exotics. In a first step towards the potential use of indigenous grasses for planting pastures, the population dynamics of thirteen important Namibian pasture grasses have been investigated (Sheuyange 1998).

Table 4 Potentially useful screened species in northern Namibia

Botanical name	Common name	Uses
Acacia senegal	Gum arabic acacia	Live fencing, gum arabic
Aeschynomene americana	Joint vetch	Reinforcement of oshanas and floodplains
Brachiaria mutica	Para grass	Reinforcement of oshanas and floodplains
Cajanus cajan	Pigeon pea	Alley cropping, fodder shrub
Centrosema pascuorum	Cavalcade centro	Reinforcement of oshanas and floodplains
Commiphora africana	Commiphora	Live fencing
Leucaena leucocephala	Leucaena	Alley cropping, fodder shrub
Macroptilium atropurpureum	Siratro	In napier grass fodder banks
Neonotonia wightii	Cooper glycine	In napier grass fodder banks
Opuntia spp.	Spineless cactus	Live fencing + drought fodder
Opuntia ficus-indica	Prickly pear	Live fencing + drought fodder
Parkinsonia aculeata	Parkinsonia	Live fencing
Prosopis juliflora	Sweet thorn bush	Live fencing + fodder
Sesbania sesban	Sesbania	Alley cropping, fodder shrub
Stylosanthes hamata	Verano stylo	Range reinforcement, undersowing maize, millet or sorghum
Stylosanthes scabra	Seca stylo	Range reinforcement, undersowing millet or sorghum
Vigna unguiculata	Cowpea	Undersowing maize, millet or sorghum

Adapted from Sweet (1998b)

4.3 Dryland fodder

Dryland fodder production is only possible in the higher rainfall north

and northeast of the country. The principal form of dryland fodder is cereal crop residues, and these make an important contribution to livestock diets in communal areas during the dry season. Some communal area farmers collect and store at least part of their residues to feed to selected animals such as milk cows and draft oxen, but most of the fodder is utilized *in situ.*

The cultivation of rainfed crops in Namibia is, of climatic necessity, mainly confined to the northern communal areas apart from a small but significant area of commercial maize production in the so-called maize triangle east of the Etosha National Park. Pearl millet is the most widely grown cereal in the communal areas, and maize (some irrigated) in the commercial areas. Wheat is only grown in the commercial areas and under irrigation. Maize is widely preferred as the staple food in the communal areas, but millet and sorghum are more reliable crops except in the highest rainfall zones. Less than 1% of communal area farmers have crop areas above 10 ha, the accepted threshold for regular commercial production. National cereal production (roughly 5% wheat, 25% maize and 70% millet and sorghum) fluctuates considerably from year to year according to rainfall. Post independence production has varied from a low of 33 800 tonnes in the drought year of 1991/92 to a record high of 173 000 tonnes in 1996/97 (Directorate of Planning, 1999).

In the higher rainfall commercial farming areas there are an estimated 9 500–10 000 ha planted to buffel grass (*Cenchrus ciliaris*) for hay. This occurs mainly in a relatively small number of substantial plantations of 5 000 ha, or more, and the total area under buffel grass is currently increasing at a rate of about 1 000 ha per year (Jürgen Hoffmann, pers. com.). With good management and some fertilization, the plantations last 10–15 years. More than 90% is the southern African cultivar, Molopo, but small amounts of the Australian cultivars Gayndah and Biloela are also grown. In the drier southern areas farmers commonly have small areas of *Opuntia* (spiny or spineless varieties) as a drought reserve. Otherwise there is very little purpose planting of dryland fodders in Namibia.

4.4 Irrigated fodder

Lucerne (*Medicago sativa*) is the main purpose grown irrigated fodder in Namibia, and is mostly found around dams in the south of the country. The largest plantation of approximately 900 ha is in the Hardap Dam irrigation scheme, and there are a further 500–600 ha at the Stampriet and Naute dams. Around Grootfontein in the north of the country, there are about 150 ha of irrigated lucerne on private farms, yielding around 12 tonnes/ha, and about 50 ha of irrigated sorghum, yielding about 20 tonnes/ha (Chris Smit, pers. com.).

The traditional varieties of pearl millet (*Pennisetum glaucum* subsp. *americanum*) are also widely grown as an irrigated fodder crop by dairy farmers, but the total area is only about 500 ha (Jürgen Hoffmann, pers. com.). The seed is purchased locally in the northern communal areas, and no special quality standards are demanded by the buyers.

4.5 Imported fodder

In times of drought Namibia has, until recently, imported large quantities of fodder from neighbouring countries and provided it at subsidized rates to farmers. According to the new drought policy (NDTF, 1997b), the fodder subsidies have been terminated in order to encourage farmers to build up their own forage reserves and to discourage them from retaining excessive stock numbers. Nonetheless, it is likely that some commercial farmers, and probably the government, will continue to import fodder in extreme drought conditions.

4.6 Constraints to pasture and fodder production and improvement

The principal constraints to pasture and fodder production, and to attempts at improvement, are as follows:

1. Low rainfall and poor soils throughout most of the country are the main constraints to the productivity of natural pastures and to the establishment of exotic pasture species.
2. Concern about exotics becoming problematic limits the introduction and testing of hardy species considered suited to the environmental and utilization rigours of the communal areas.
3. The availability and price of seeds for pasture/fodder improvement are major constraints to communal area farmers.

4. Considerable portions of the savannah vegetation types in the freehold farms are severely bush infested, but the costs of thinning/clearing generally outweigh the benefits in terms of increased carrying capacity.
5. The open access to rangeland grazing, at least within communities, in the communal areas necessitates broad collective agreement and cooperation in any pasture improvement venture.
6. Conventionally, communal area farmers do not retain exclusive use of their unfenced croplands after harvest for their own livestock, so limiting the opportunities and incentives for undersowing or alley cropping.

5. PASTURE SEED PRODUCTION

There is no formal certification of pasture/fodder seed in Namibia. As mentioned in section 4.4, the pearl millet seed used by commercial dairy farmers for irrigated fodder comes from the communal areas, is not purposely grown as a fodder seed, and meets no particular quality criteria. South African seed merchants regularly buy seed in Namibia and are interested in both the traditional and improved (Okashana) types of pearl millet. They buy up to 400 tonnes per year and it is used mainly as a silage crop (babala) by dairy farmers in South Africa (Jürgen Hoffmann, pers. com.) The buffel grass producing farmers tend to grow their own seed and also produce a surplus which is sold to the South African seed merchants, who conduct their own germination tests.

With the long-term goal to preserve germplasm (in most cases, seeds) of the entire Namibian flora, the National Plant Genetic Resources Centre in Windhoek focuses at present on preservation of seeds of plant species of economic importance. A wide variety of Namibian pasture grasses, e.g. of the genera *Anthephora, Brachiaria, Cenchrus, Cynodon, Panicum, Pennisetum, Setaria* and *Stipagrostis* are included in the current accessions.

6. RESEARCH AND DEVELOPMENT

6.1 Institutional structure

The Ministry of Agriculture, Water and Rural Development (MAWRD) is the key institution dealing with forage resources. The Department of Agriculture and Rural Development is divided into five directorates, two of which directly deal with pasture resources. The Directorate of Research and Training investigates rangeland and pasture science related topics, amongst others, while the Directorate of Extension and Engineering Services provides a direct link to farmers and implements pasture science related programmes.

The Directorate of Research and Training consists of three divisions, with the Division Plant Production housing the Pasture Science subdivision and the National Botanical Research Institute. The MAWRD maintains fifteen agricultural research stations, mostly located in central and northern Namibia.

Namibia's National Agricultural Research Plan states the main objective to be improvement of research in natural resource management (Namibia Agriculture Research Plan 1996). On a project basis, pasture science related programmes deal with rangeland reclamation, carrying capacity, agro-forestry and rangeland management systems. Due to increasing range degradation, pasture rehabilitation, bush control and pasture management systems have been allocated highest priority.

Examples of individual on-going projects related to pasture science are (Namibia Agriculture Research Plan 1996):

- Veld reclamation on denuded veld in communal areas of Namibia.
- Evaluation of saline tolerant vegetation as a source of fodder for livestock.
- The effect of bush control measures and grazing on the species composition and bush densities

The Division of Training maintains four agricultural training colleges, three in northern and one in central Namibia near Windhoek, and carries out topic-oriented, informal training courses. Two of these

colleges, Neudamm and Tsumis conduct their own pasture/fodder trials, while the other two are used as locations for trial work by development projects with a research component.

Botanical research is conducted by the National Botanical Research Institute of the MAWRD. Outside of government, the most significant organization involved in environmental research is the Desert Research Foundation of Namibia (DRFN) which pays particular attention to sustainable use of the country's natural resources. The DRFN jointly administers the Namibian Programme to Combat Desertification (NAPCOD) with the Directorate of Environmental Affairs of the Ministry of Wildlife and Tourism. In addition, some of the externally funded development projects operating in the communal areas have components of adaptive research.

6.2 Personnel

The key organizations/individuals and their current areas of activity/interest with relevance to pasture science are as follows:

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Dr Gillian Maggs-Kolling, Director: maintaining national herbarium
Mr Ben Strohbach, Co-ordinator Vegetation Mapping Project: revising the vegetation map of Namibia
Mrs Herta Kolberg, Head, National Plant Genetic Resources Institute of Namibia: germplasm collection of indigenous flora and dryland crop and fodder species
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Dr. Mary Seely, Executive Director Water Management: sustainable natural resource management
Mr Bertus Kruger, Deputy Director Rangeland Management: sustainable range management
Mr Mark Robertson, Researcher: bush encroachment studies
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Mr Axel Rothauge, Lecturer (Animal science): range management, cultivated pastures
Mr Leon Lubbe, Lecturer (Pasture Science): range management, research methodology
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Mrs Sophia Kasheeta, Acting Project Co-ordinator: sustainable rangeland management in communal areas
Northern Regions Livestock Development Project (NOLIDEP), P O Box 4783, Windhoek.
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Mr Gerhard Mouton, Senior Extension Technician: sustainable range management and adaptive research in the northern communal areas

7. REFERENCES

de Pauw, E., Coetzee, M.E., Calitz, A.J., Beukes, H. & Vits, C. 1998. *Production of an agro-ecological zones map of Namibia (first approximation), Part II: Results*. Agricola: 33-43.

Directorate of Planning. 1999. *Agricultural statistics bulletin, September 1999*. Ministry of Agriculture, Water & Rural Development, Windhoek.

Engelbrecht, G.F. 1997. *Saline water project: fodder production in the southern communal areas.* In: B. Strohbach (ed.) Proceedings of the National Annual Agriculture Research Reporting Conference, Windhoek.

FAO 1973. *Soil map of the world*. UNESCO, Paris.

FAO 2005. *Online statistical database*, FAO Rome.

Giess, W. 1971. *A preliminary vegetation map of South West Africa.* Dinteria 4: 5-114.
IFAD. 1997. *Northern regions livestock development project: Reformulation report, July 1997.* IFAD, Rome.
Isaacson, B. (Ed.) 1995. *Namibia food security and nutrition assessment report*. National Food Security and Nutrition Technical Committee, Windhoek.
Le Houerou, H.N. 1984. *Rain use efficiency: a unifying concept inland use ecology.* J. Arid Environ. 7:213-247.
Muller, M.A.N. 1984. *Grasses of South West Africa/Namibia*. Department of Nature Conservation, Directorate of Agriculture and Forestry, Windhoek.
Namibia Agriculture Research Plan. 1996. Ministry of Agriculture, Water and Rural Development, Windhoek.
NDTF. 1997a. *Towards a drought policy for Namibia. A discussion document prepared by the National Drought Task Force for a workshop at Neudamm Agricultural College 11-13 March 1997.* National Drought Task Force, Windhoek.
NDTF. 1997b. *National drought policy & strategy*. National Drought Task Force, Windhoek.
Sheuyange, T.P. 1998. *Aut-ecology of some of the most important pasture grasses.* In: J.F. Els (Ed.) Proceedings of the Second National Annual Agriculture Research Reporting Conference, Neudamm 1998.
Sweet, R.J. 1998a. *A rainfall model for estimating carrying capacity*. Northern Regions Livestock Development Project (NOLIDEP), Windhoek.
Sweet, R.J. 1998b. *NOLIDEP adaptive research programme 1996-1998 Summary*. Northern Regions Livestock Development Project (NOLIDEP), Windhoek.
Sweet, R.J. 1999. *Livestock – Coping with drought: Namibia – a case study*. Paper prepared for FAO electronic conference on drought. FAO, Rome.
Van Eck, J.A.J., Bester, F.V. & Van Lill, C. 1998a. *The introduction of some fodder species to be used as live fences and windbreaks in the southern communal areas.* In: J.F. Els (Ed.) Proceedings of the Second National Annual Agriculture Research Reporting Conference, Neudamm 1998.
Van Eck, J.A.J., Bester, F.V. & Van Lill, C. 1998b. *The introduction of some fodder species in the southern communal areas of Namibia.* In: J.F. Els (Ed.) Proceedings of the Second National Annual Agriculture Research Reporting Conference, Neudamm 1998.

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[The profile was prepared by the author in 2000 and modified by S.G. Reynolds in August 2006 to update some livestock statistics.]