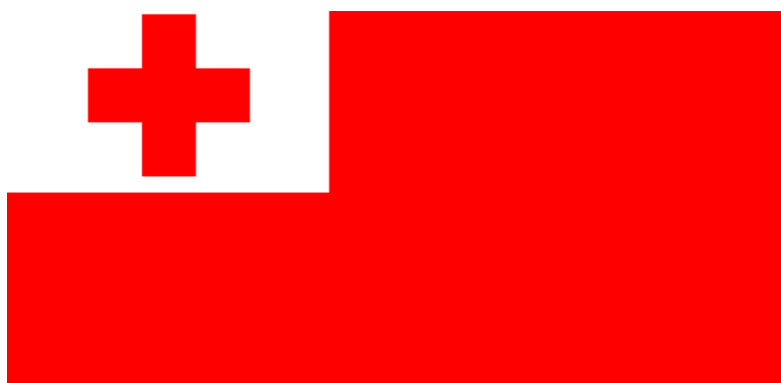


Country Pasture/Forage Resource Profiles

TONGA



by
Stephen Lee



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CONTENTS

1. INTRODUCTION	5
2. CLIMATE AND AGRO-ECOLOGICAL ZONES	5
3. SOILS AND TOPOGRAPHY	6
4. PASTURE BASED LIVESTOCK PRODUCTION SYSTEMS	7
4.1 Beef production	7
4.2 Dairy production	8
5. CONSTRAINTS TO DEVELOPMENT OF PASTURE-BASED LIVESTOCK SYSTEMS	8
6. THE PASTURE RESOURCE	9
6.1 Current resources	9
6.2 New initiatives in forage improvement	9
7. ORGANIZATIONS AND PERSONNEL INVOLVED IN PASTURE RESEARCH AND DEVELOPMENT	11
8. REFERENCES	11
9. CONTACTS	12

1. INTRODUCTION

The Kingdom of Tonga is an archipelago of 172 coral and volcanic islands of which only 36 are inhabited. The total land area is 747 km². It is located in the South Pacific Ocean at about 173° E longitude and 22° S latitude (see Figure 1).

There are three main island groups: Tongatapu, the largest island, where the capital Nuku'alofa and most of the population is found, and Eua in the south; Ha'apai in the centre; and Vava'u in the north. There are also several islands far to the north known as the Niua (Situa, 1996).

The population of Tonga in 2001 was estimated at around 105 000 while the 2006 census gave 101 991. Latest SPC estimates (SPC, 2008) for mid-2008 are 102 724 and for mid-2010 are 103 641 (with a growth rate 2008–2010 of 0.4%). According to the World Factbook the July 2008 population estimate is 119 009 with a growth rate of 1.669%. Of the population >90% is Polynesian. Population growth was low, due to the high rate of emigration but for 2008 is estimated at 1.669% by the World Factbook (but lower by SPC). Internal migration to Tongatapu is also common. In both cases, migration is generally undertaken to improve income and educational prospects.

The political system is a constitutional monarchy in which the King retains considerable powers.

According to the constitution, land is distributed to all adult Tongan males by the Crown (King or Queen) through the government and the nobles. Larger hereditary estates have been allocated directly to hereditary nobles. The ['api uta] farm land, traditionally allocated to every Tongan male on reaching 16, covers 8 acres [3.4 ha] of bush land, for which a very low rent is paid to the Crown. Due to population pressure, this acreage has been reduced and in many areas land is not available for allocation, so this system may not survive. Livestock productivity is low, and with around 10–11 000 cattle, imports of beef and veal are greater than can be met by local production (Table 1), as well as considerable imports of mutton and lamb, chicken and milk both fresh and in other forms.

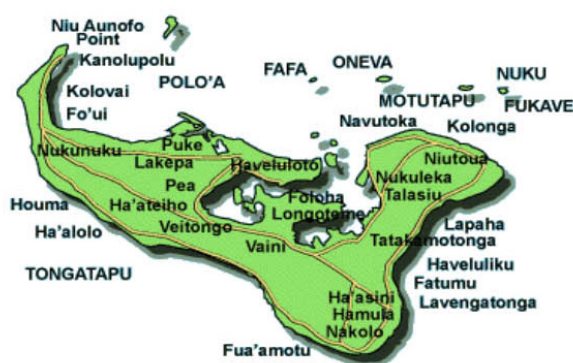
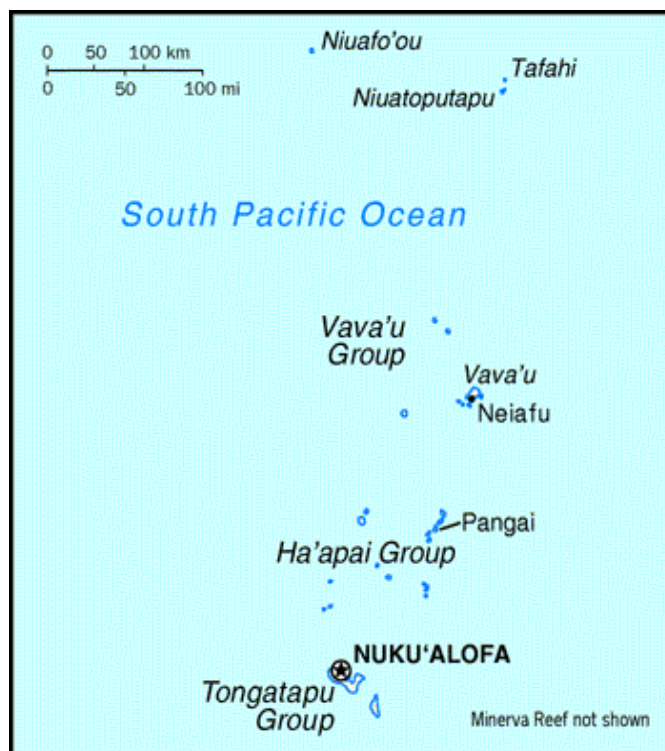


Figure 1. Map of Tonga

2. CLIMATE AND AGRO-ECOLOGICAL ZONES

Whilst tropical, Tonga has generally a cooler climate than the rest of the Pacific islands, largely due to its southerly latitude and consistent trade winds which limit humidity and moderate temperature over land. The annual mean maximum and minimum temperatures are 27 °C and 15 °C respectively. Climatic information is given for each of the main islands below.

Table 1. Tonga statistics for livestock numbers, beef and veal meat and milk production, cattle imports and beef and veal imports for the period 1997–2007

Item	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cattle nos. (,000)	9.5	9.5	10.3	11.25	11.25*	11.25	11.25	11.25	11.25	11.25	11.25
Goat nos.(,000)	12	12	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.6
Pig nos.(,000)	81	81	81	81	81	81	81	81	81	81	81.2
Beef & veal prod. (mt)	266	266	304	350	342	342	342	342	342	350	360****
Milk prod. (mt)	150	150	179	370	370	370	370	370	370	370	370
Cattle imports (,000)	508	-	-	-	33	-	77	77	35	-	n.r
Milk fresh imports (mt)	47	138	1207	805**	750	469	385	487	662	510	n.r
Mutton and lamb imports (mt) (,000)	2.4	3.3	2.0	2.5	2.7	2.1	2.2	2.7	3.0	3.1+	n.r
Beef & veal imports (mt)	741	522	546	114***	322	328	370	349	263	167	n.r

Source: FAO Database 2009 (n.r.= no record)

* Data for cattle numbers vary somewhat according to source; according to the 1996 Agricultural Census (Funaki, 2001) there were 2 463 households with cattle and a total of 9 318 cattle in Tonga while Macfarlane (1998) indicates 8 000 for 1997 and SPC (unpublished data) 9 318 in 1996. The Agriculture Census 2001 figures indicated cattle numbers of around 10 354 in 2 320 households.

** In 2000 total milk equivalent imports were 5 041 Mt and in 2006 were 5 015 Mt.

*** In addition imports of beef preparations were 823 Mt in 2001 and 658 Mt in 2002 and 438 Mt in 2005.

****Total meat production (beef, goat, pig and chicken) was 2 268 Mt in 2007

+In addition in 2006 some 3 768 Mt of chicken meat were imported

- Tongatapu: The mean monthly maximum and minimum temperatures are 27 °C and 24 °C respectively. While average annual rainfall is 1 900 mm, droughts of moderate severity are common for 2 months, and occasionally for up to 4 months, during the period July - November (Situa, 1996). There is little original vegetation remaining, and most land is either cropped or in bush fallow. Approximately 50% of the island has an overstorey of mature coconuts with regular cropping and livestock activities carried out beneath.
- ‘Eua: Climate data are not available for this island, however, due to its higher elevation, ‘Eua has slightly higher and better distributed rainfall than Tongatapu, and a reputation for being less affected by drought.
- Ha’apai: The mean monthly maximum and minimum temperatures are 25.5 °C and 23.5 °C, respectively. Average annual rainfall is 1 680 mm, which is not usually sufficient to support plant growth during the dry season and frequent droughts occur in the period June - August. Soil erosion occurs as a result of high intensity rainfall (including hurricanes) during the wet season from November to March (MAF, 1997).
- Vava’u has mean monthly maximum and minimum temperatures of 28.3 °C and 22 °C, respectively. Average annual rainfall is 2 222 mm, and prolonged droughts occur, on average, every 7 years. In most years, a dry spell of 1–2 months can be expected in the period June–September. This is more marked in eastern areas where rainfall tends to be lower. Because of higher and more even rainfall distribution, Vava’u possesses greater agricultural potential and flexibility than Tongatapu (RAFA, 1993).

3. SOILS AND TOPOGRAPHY

The Tongan archipelago lies roughly in a North - South direction. The soils of Tonga are derived from a mixture of volcanic ash and coral. Because island groups are isolated from each other, and are physically and economically different, the country is described in four parts.

- Tongatapu island is mainly flat, with a few small hills rising to about 30 m, and with a coral base covered with around 3 m of volcanic ash. Land area is 259 km². Close to two thirds of the country’s population live on Tongatapu. With the exception of a few salt-affected coastal areas, soils are highly productive, easily cultivated and suited to a range of vegetable, root and tree crops as well as pastoral farming.
- ‘Eua island lies 40 km south-east of Tongatapu. It is a high volcanic island with soils derived from andesitic tephra overlying tuffaceous materials and/or coral. Extensive forests and some plantation forestry

cover the range of hills which run for most of the length of the island on the eastern side. Most farming occurs on the gentle slopes and on flat terraced land of the western half of the island. Soils are fertile, and with the exception of southern areas where coral outcrops are found, are easily cultivated.

- Ha'apai, 150 km north of Tongatapu in the centre of the archipelago, is a group of 43 coral islands, 18 of which are permanently inhabited, with very low topography and coraline soils. The total land area is 110 km². Population was 8 148 in 1996 in 28 villages. The natural vegetation pattern shows secondary fallow vegetation in all island groups of Ha'apai. All islands have a cover of coconuts, but few other trees, to protect the land from wind and salt spray, and for this reason, soil erosion is a problem. The consequence of erosion, and the practice of slash and burn agriculture, has been a decline in soil productivity (MAF, 1997). Soils vary from island to island. The higher, older islands with more than one terrace, possess good quality soils capable of producing a wide range of crops and forages, while the younger lower islands have less fertile, drought prone sandy soils of very limited productive capacity. Most of these low islands are uninhabited.
- Vava'u is the main northern group of islands. It is the second largest group with a total land area of 119 km². Most of the population, estimated at 16 000 in 1996, live on the main island of Vava'u, or islands joined to Vava'u by causeways. The natural vegetation pattern is characterized by a series of concentric rings from the coast to the Island's centre. Besides changes in soil type, the natural vegetation pattern is a result of the influences of salt in the soil, of wind intensity, and of salt spray, which decrease with increasing distance from the coast. Additionally, vegetation tends to be heavier in the west due to higher and more even rainfall and lesser influence of salt spray which is blown on the prevailing east and north-easterly winds. The creeping grass and bush vegetation of the beach has been replaced by a narrow strip of coastal forest. Lowland rain forests of high density and high biomass production dominate the interior of the land. However, intensive agricultural development has transformed much of the land in Vava'u into inter-cropped coconut plantations or secondary fallow vegetation. Rainforest remnants persist largely on areas considered too steep for agricultural use.

The main islands of the Vava'u group originated from raised coral. They have a characteristic terraced silhouette and appear to be 3-tiered. Vava'u, the largest island, has a maximum elevation of 213 m. The soils of the group are developed largely on a substantial mantle of volcanic ash, up to 9 m thick, overlaying the coral limestone. It is mainly on steeper sites and recently accumulating beach areas that coral based soils are found. The best agricultural soils in Vava'u are found in the west and central districts whilst those in eastern areas tend to be shallower, have old very hard clay, and are of lower natural fertility (RAFA, 1993).

4. PASTURE BASED LIVESTOCK PRODUCTION SYSTEMS

4.1 Beef production

There are two distinct beef production systems:

- Large commercial style properties operated by the nobles, entrepreneurs who sub-lease land and the churches. There are only a few such properties; however, they are very important in their ability to produce a surplus of meat and milk for local markets and of breeding stock for the industry as a whole. These properties tend to specialize in milk and beef production, often with separate beef and dairy herds. They have some well developed fenced long-term pastures, and land is generally cropped only during the pasture renewal phase. Cropping is generally carried out on separate areas devoted to this practice.
- Smallholder livestock farmers, who raise livestock in small numbers. Very often the purpose of such enterprises is to supply animals for traditional social obligations such as funerals, weddings and church functions. Livestock raised include beef and dairy cattle, goats and horses. These properties are almost always the 'api uta, or tax allotment, referred to earlier. Animals are most commonly tethered, and graze roadsides, fallow crop land or under-utilized bushland. Crop production tends to be the first priority of small farmers, and livestock tend to be integrated into this system.

4.2 Dairy production

The dairy sector can be divided into two easily differentiated sub-sectors:

- (a) Institutionally owned farms. These 5 farms are generally large with 70 – 110 cows; they are run by paid staff and with one exception practice machine milking twice a day. Most of the milk produced is supplied to the Tonga Dairy Processing Company for treatment, although each farm sells some of its milk directly to consumers.

Estimated dairy production for the three dairy farms located on Tongatapu is 5.5 L per cow per day, with seasonal variation from 7.5 L per day in the wet season (February) to 3 L per day in the dry season (September). Annual production is about 1 100 L per cow. The main constraints to improved production are poor feeding, poor pasture and herd management, high incidence of mastitis, and lack of replacement heifers.

- (b) Smallholder dairy farmers. This sub-sector has been revitalised since commencement in September 1998 of a MAF Tonga – FAO project on smallholder forage-based dairy production (see Project TCP/TONGA/8821). Following cessation of FAO funding in August 2 000 activities supporting smallholder dairy farmers have been carried on by MAF Livestock extension personnel. Smallholders are practising a variety of management and feeding systems. These include once and twice a day milking, cut and carry feeding of hybrid elephant grass, improved and unimproved pastures, use of supplements such as copra meal, use of crop by-products for feeding, urea supplementation. Consequently there is a wide variation in daily production from 4 – 10 litres/cow/day.

The smallholders who are located in all island groups pasteurize and pack their milk in plastic sachets for sale in village areas. They report very good levels of profitability and consumer demand.

Development of dairy production in Tonga under improved management conditions is a potential new industry. Factors which encourage the development of the dairy sector are:

- Good potential for growing improved grasses such as elephant grass and signal grass and using naturalised guinea grass, to contribute to a better dairy cow feeding regime, through cut and carry of green forage, or hay or silage making.
- Fertile soils and relatively high and well distributed rainfall.
- There is a growing market for milk in Tonga which is presently satisfied by imports of long-life milk and powdered milk. The local milk share is only 15% of the market.
- There is an established dairy processing plant and a well-equipped laboratory producing pasteurised milk and flavoured milk.
- The Government is highly supportive of dairy production and through the Tonga Development Bank and MAF Tonga has facilitated the importation of 2 small shipments of dairy heifers from Fiji. This was in response to farmer demand for breeding stock.

5. CONSTRAINTS TO DEVELOPMENT OF PASTURE-BASED LIVESTOCK SYSTEMS

There are a number of constraints on increasing productivity of pasture based systems including:

- Livestock may not be raised for commercial purpose. Rather than being exchanged for cash in a formalised meat marketing system, much locally produced meat is used as a gift to meet social obligations at events such as weddings and funerals. This appears to be a relatively successful and equitable, cash free, means of distributing dietary protein. However, without careful planning, this system of event driven off-take does pose a major obstacle to the long-term viability of small breeding operations.
- Market opportunities for locally produced meat and milk are limited, particularly away from Tongatapu, this is due to both lower incomes in rural areas and (possibly more importantly) a lack of appropriate processing, distribution, refrigeration, and marketing infrastructure. Consequently farmers have to split their time and resources between production, processing, distribution and sales.

- Breeding stock can be difficult to acquire, as the national herd is small and fragmented, and the risk of in-breeding is ever present.
- Nationally, a lack of farmer training, machinery and a poor water supply hamper all agricultural development.
- Larger properties tend to suffer from under-developed commercial farm management skills.
- There is a lack of recognition of the potential to integrate forage based agriculture with cropping based agriculture, and this has meant that land which could be best used for cropping and pasture based production, is restricted to cropping only.
- The remoteness of some areas, particularly Ha'apai and the Niua's, with their weak economic and infrastructural base makes it difficult to establish any enterprise.
- Dry season feed shortages tend to decrease animal performance in the short-term and, more importantly, often result in the loss of high quality, but drought sensitive pastures, through poor management and overstocking.

6. THE PASTURE RESOURCE

6.1 Current resources

No data are available for pasture areas as these are not included in agricultural surveys. Currently, managed improved pastures are found mainly on Tongatapu. Most cattle are grazed on unimproved fallow land, but in most areas, leading farmers have improved the grazing environment using locally available resources. A common method is the introduction of guinea grass by seed at the end of the cropping cycle, this need only be done one time. As a result of recent and ongoing developments in smallholder dairy production, increasing areas of improved pastures and forages are being established in all island groups (except for the Niua's). The main pasture being developed is signal grass combined with siratro and centro. Smallfarmers are also planting hybrid elephant grass for cut and carry feeding, and as a dry season feed resource.

Guinea grass [*Panicum maximum*] is the most common improved pasture variety. However, it is rarely planted but is common on roadsides and fallow areas. In places where mechanical cultivation and commercial cropping is carried out, guinea grass will re-establish from seed in the soil 3-4 months after ploughing, and the grass forms a valuable potential ley between short term crops such as squash. Signal grass [*Brachiaria decumbens*] is the main planted improved pasture grass variety. Given the very good fertility of soils in most areas, pasture legumes also grow readily. Most islands have naturalized areas of potentially valuable forage legumes including siratro [*Macroptilium atropurpureum*] and centro [*Centrosema pubescens*]. These varieties establish well and persist in rotational cropping - fallow systems.

In 1990, a project on legume adaptation and seed production identified six legume varieties which were potentially well adapted to Tongan conditions, namely: *Desmanthus virgatus*, *Clitoria ternatea*, *Stylosanthes hamata*, *Stylosanthes scabra*, *Aeschynomene elegans*, *Aeschynomene americana* (Moala 1993). However, the naturalized herbaceous species siratro, centro, glycine and shrub legumes such as gliricidia (*Gliricidia sepium*), appear to have the most immediate potential due to readily available planting material and their obvious ability to thrive in Tongan conditions.

Most cattle graze fallow cropping land, and are seen as weed controllers which simplify crop preparation. The majority of the grazing resource lies under mature coconuts, on larger farms. Those practising mechanical cultivation often thin the coconuts to approximately 70–100 stems/ha from about 125 stems/ha to facilitate tractor access.

6.2 New initiatives in forage improvement

Thompson [1988] reported that Tongans are changing from the traditional planting pattern of 9x9 m to 10x10 m square plantings to 5x15 m "hedge" plantings to increase light penetration and thus enable more crops to be grown. Opio [1990] advised that, using this method, the number of stems per hectare is maintained at about the same as for conventional planting but copra production is generally higher,

sometimes up to 25%. The yields of crops grown beneath the palms are also considerably higher. Tonga has pioneered practical investigation of coconut spacing patterns for inter-cropping, including a system where clumps of 4 palms are planted in rows 15 m apart under senile palms [Reynolds, 1995].

In recent years, due to the long-term downward trend in copra prices, coconut has become of secondary importance to the inter-crop. Often export crops such as squash pumpkin are grown, but also food crops are planted and consumed domestically. The average age of coconut stands in Tonga is now very old [estimated at 60 years plus]. These old stands have a naturally high level of light penetration which is estimated at 75–80% of ambient. This, combined with the increase in light penetration due to hedge planting, has radically improved the potential for pasture performance under coconuts in Tonga. There remains however considerable need and potential for research into the integration of forage based livestock production in Tongan farming systems.

Lee and Macfarlane (1996) identified priorities for improvement of forage based livestock production in Tonga as:- (a) increasing the area of legume based in pastures through the wider use of localised herbaceous legumes, (b) increasing the area and availability of drought tolerant forages for the dry season using hybrid elephant grass and shrub legumes, and (c) increasing the availability of improved planting material through domestic production and distribution within and between islands.

Other Government initiatives include:

- The Ministry of Agriculture and Forestry [MAF] has identified forage development as a key method of increasing meat and milk production from ruminants and horses. By so doing, rural household incomes should improve and imports reduce.
- A farmscale demonstration showing how grazing and cropping can be integrated has been established. It is expected that over time the demonstration will show farmers the benefits to the farming system of integrating pastoral and crop farming, particularly in terms of lower crop establishment costs and better incomes from livestock sales and higher crop yields resulting from better soil productivity.
- During and subsequent to the MAF Tonga – FAO Smallholder Forage Based Dairy project, MAF has been carrying out a countrywide programme of training and demonstration for small pastoral farmers. This has included the establishment of improved forage species nurseries (mainly signal grass and hybrid elephant grass), and the location of accessible herbaceous legume seed nurseries (centro, siratro, glycine) in all island groups. Training is given in pasture establishment and management, dairy animal husbandry, farm management, record keeping, milk handling and processing.
- The Ministry of Agriculture and Forestry [MAF] has recently been restructured and the integration of livestock extension services into the newly formed Research and Extension Division should enable MAF to better meet farmers needs.
- In co-operation with MAF, the Development Bank of Tonga has commenced a programme of breeding stock [cattle] imports from Fiji. This promises to be a low cost, technically appropriate method of meeting the demand for dairy breeding animals, and preventing inbreeding.
- Since 1997, a number of new feeding technologies and forage varieties have been introduced. The main aim has been to improve meat and milk production by increasing forage quality/intake and improving dry season feed availability. A most promising hybrid napier grass [*Penisetum purpureum*] was imported from Samoa and is being adopted by dairy farmers as a cut and carry feed for cows at milking time, and for dry season feeding to other classes of livestock. Buffalo grass (*Stenotaphrum secundatum*) was imported from Vanuatu. It is hoped that this will provide a useful grazing resource for smallholders, particularly in shaded areas on coralline soils where management levels are low. This grass is currently under assessment.
- The use of locally available feeds made from agro-industrial by-products has been introduced and demonstrated. This includes the manufacture of silage for milk production and dry season feeding, the use of urea as a feed supplement, the smallscale production of fish meal, the production of multi-nutritional feed blocks using locally available ingredients and the use of copra meal and molasses as feeds. These feeds and technologies are appropriate and highly complementary to pastoral production in Tonga and should be further promoted.

Some other recommended initiatives include:

- Promotion of fodder trees/shrubs for use as a high protein feed supplement e.g. *Gliricidia sepium*, *Leuceana leucocephala*, and *Sesbania grandiflora*.
- Use of supplements made of locally available agricultural and industrial by-products such as banana by-products (rejected banana, banana leaves and pseudo stems), cassava by-products (roots and leaves), brewer's spent grains, fish wastes and squash/pumpkin.
- Possible development of silage from local by-products for off-season feeding, and multi-nutrient blocks containing urea (10%) and local by-products.

7. ORGANIZATIONS AND PERSONNEL INVOLVED IN PASTURE RESEARCH AND DEVELOPMENT

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Tonga Website

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