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2019 Population Report for the Tuli Cattle Breeders' Society of South Africa

SA STAMBOEK STUD BOOK

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Introduction

Increased selection pressure on many domestic animal species and breeds has led to an increase in production efficiency at the expense of genetic diversity and the survival of many breeds across the world. About 8000 breeds of livestock species have been domesticated, of which 631 are classified as extinct and 1710 are classified as being at risk (FAO, 2011). The concerns with regard to the loss of genetic diversity are however, not only concerned with the extinction of breeds, but also the loss of genetic diversity within breeds. Loss of genetic diversity within breeds can negatively affect adaptation (the ability of a population to respond to natural and human selection) and fitness traits (the capacity to produce fertile offspring). It is therefore necessary to monitor the genetic diversity of breeds to guarantee survival in the long run.

There are several factors that are used as key parameters in monitoring genetic diversity in breeds. These parameters include effective population size, inbreeding levels and average genetic relationships (Groeneveld et al., 2010). Effective management of animal genetic resources depend on comprehensive knowledge of breed characteristics. The availability of pedigree data offers a great opportunity to investigate and assess genetic diversity within a breed. In this study genetic diversity parameters for the Tuli population in South Africa were investigated. This will give an indication if the population is at risk of losing genetic diversity or not.

Origin & History

The Tuli is a Sanga breed that originated in Zimbabwe in the 1940's on a farm on the Guyu Creek, a tributary of the Tuli River, which became known as the T.B.S (Tuli Breeding Station). On 21 April 1951 the first polled bull (son of the Base Sire, Mahuke, who was scurred) was born in the dry riverbed of the Guyu Creek. He was named Guyu and his influence so enormous that it was later decided to name the herd after him. Today on historical pedigrees he features as GUYUGUYU. Tuli cattle from the herd were also available to commercial farmers and in 1961 the Tuli Breeders Association was formed.

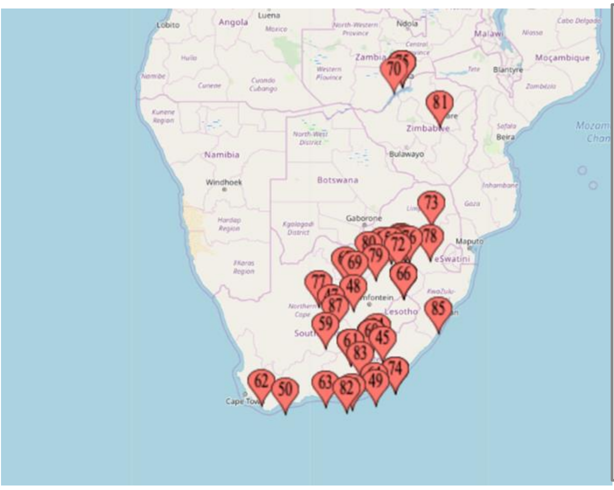
Towards the end of 1976 the first Tulis, a group of thirty pregnant females and three bulls, were imported into South Africa from the T.B.S in Zimbabwe. The first Tulis were introduced to the South African public at agricultural shows. Information days and prestige auctions were held and gradually the Tuli made its mark in South Africa too. The Tuli Cattle Breeders Society was officially formed on 24 March 1994 having been preceded by a Tuli Club. For a full history, see www.tulicattle.co.za. Tuli animals from Zimbabwe are identified on the Logix data base by ZW preceding the herd name.

Data & Methods

Pedigree data of the South African Tuli population were obtained from SA Stud Book's Logix data base, as used in the BLUP genetic evaluation analysis. The total population consisted of 77 564 animals, born between 1945 and 2018, of which 41 606 (53.6%) were female and 35 958 (46.4%) were male.

Population parameters were determined with the German program PopReport (Groeneveld, E., et al., 2009. *Genetics and Molecular Research, 8(3):115*) and the Nordic program EVA (Berg P et al., 2006. *WCGALP, 2006, s.246*), which calculates parameters for monitoring populations for genetic diversity parameters like inbreeding and effective population size, as well as influential animals currently and in the history of the breed. PopRep was developed by the Department of Animal Breeding and Genetics of the Institute of Farm Animal Genetics (FLI). PopRep results are presented in 3 reports, which are also available, and states in detail the methods and results presented in this report. EVA was developed by Peer Berg and Anne Præbel of NordGen. NordGen Farm Animals is a Service and Knowledge Centre for Sustainable Management of farm animal genetic resources (Nordic countries).

Currently Active Breeders & Animals



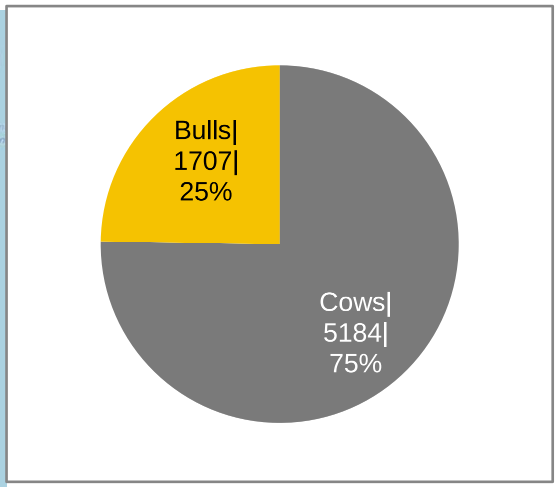
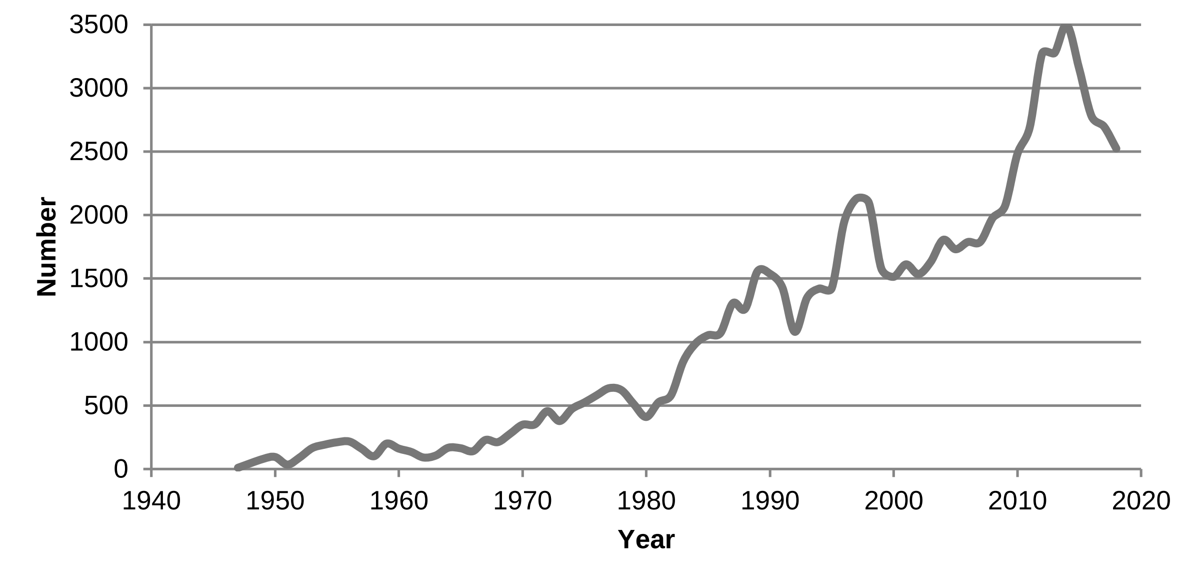


Figure 1: Distribution of breeders.

Figure 2: Currently active Tuli animals

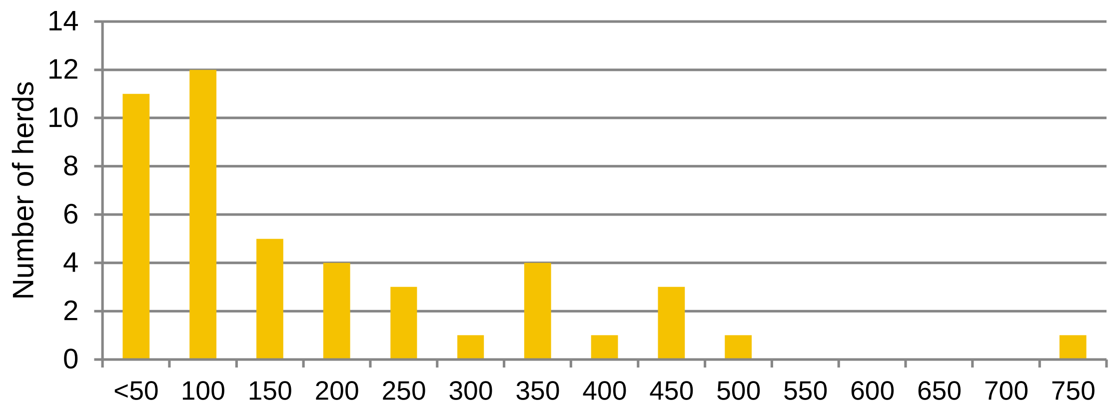
Currently (11/08/2019), there are 42 breeders of Tuli cattle of which all 42 participate in production recording. The distribution of South African breeders is shown in Figure 1, with one breeder in Zimbabwe and 4 in Zambia. Figure 2 indicates that there are 5184 cows (75%) and 1707 bulls (25%) active (alive) on the database, a total of 6891 animals.

Figure 3: Number of animals born per year



There were around 2500 Tuli calves born in 2018, down from 3500 calves born in 2012. The population parameter reports require a full year's calves to estimate the effect of influential animals on the current population (GC and AGR scores). The effect of influential ancestors was thus calculated on the 2524 registered calves born in 2018.

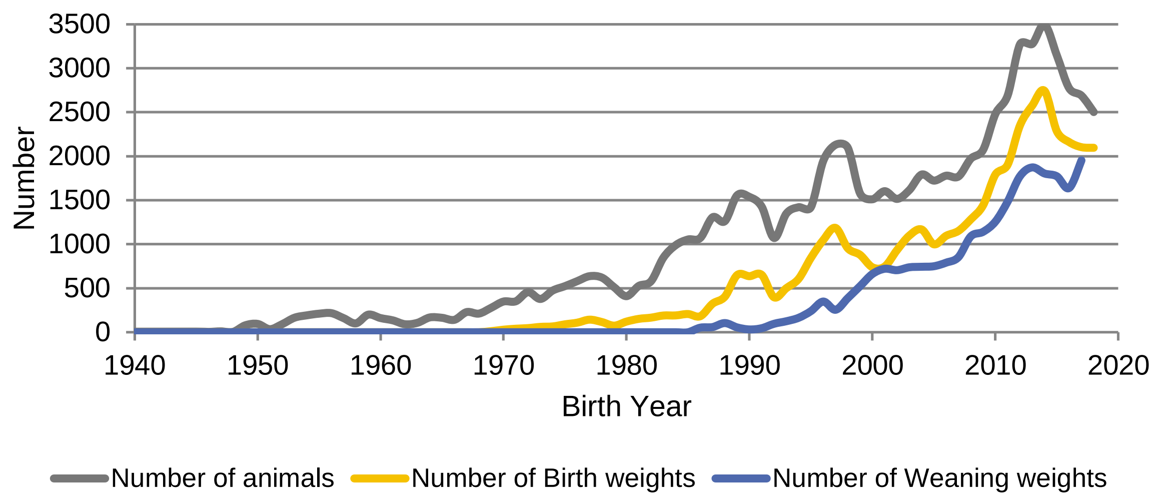
Figure 4: Herd Size



Most herds have less than 100 animals, although several larger herds also exist. The largest herd has 750 animals.

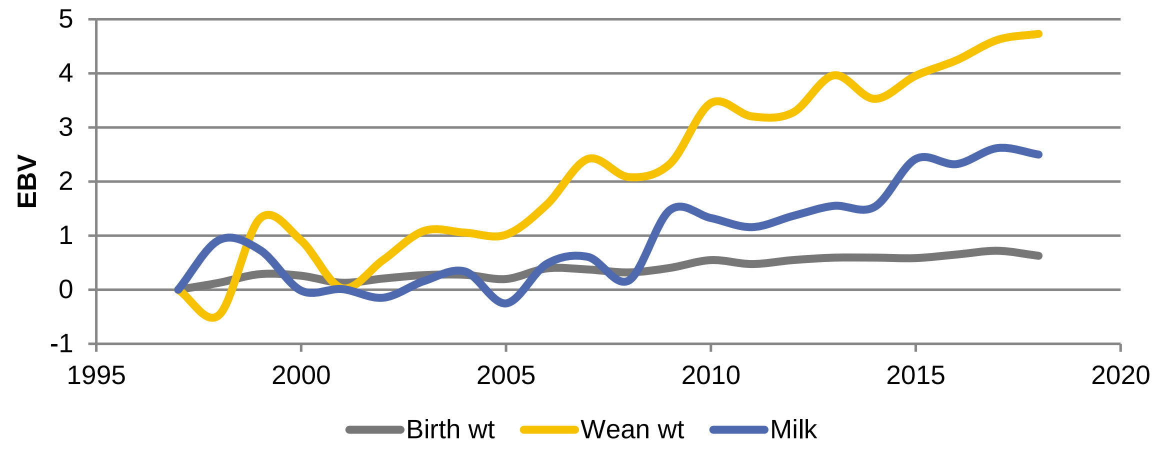
Performance Measurement

Figure 5: Number of animals weighed at birth and weaning



All Tuli stud herds are registered for performance measurement as well, and from Figure 5 it can be seen that a high percentage of calves are weighed at birth and weaning. Tuli breeders receive monthly genetic evaluations for their animals, and participate at all levels of performance testing, receiving breeding values for both farm and intake post-wean growth tests for young breeding bulls and as well as for carcass traits.

Figure 6: Genetic trends

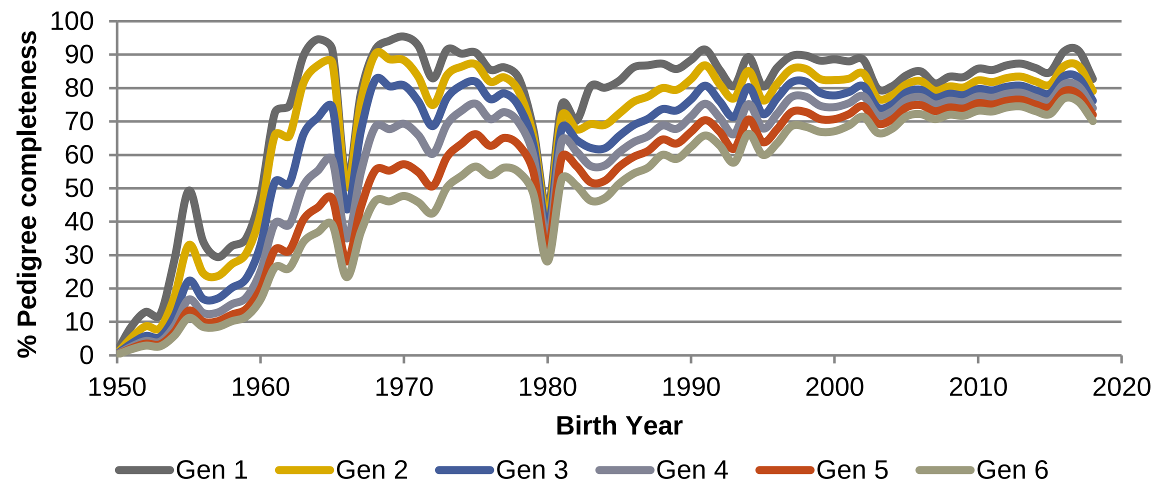


From the genetic trends in Figure 6, it can be seen that Tuli breeders have selected for increased weaning weight and milk, while keeping birth weight constant.

Pedigree Completeness

The estimation of inbreeding coefficients is highly dependent on the pedigree completeness of an animal or breed. The more complete the knowledge of an animal's pedigree, the more reliable is its estimate of inbreeding. Groeneveld uses the method of MacCluer et al (1983) to measure pedigree completeness in the breed, which indicates the proportion of known ancestors in each ascending generation. The Figure shows the pedigree completeness for 6 generations deep of the Tuli population.

Figure 7: Pedigree Completeness of the Tuli breed



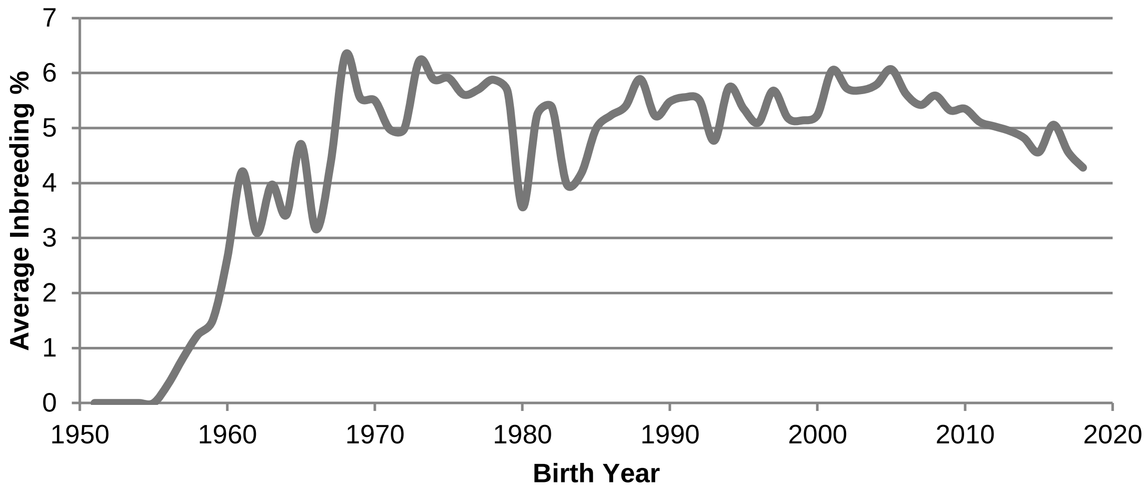
The average pedigree completeness for animals born within the last 10 years: 1 generation deep (both parents known) = 86.9%; 2 generations deep (grandparents known) = 83%; 3 generations deep = 80.3%; 4 generations deep = 78.1%; 5 generations deep = 76%; 6 generations deep = 73%. This indicates that pedigrees are recorded but that some degree of upgrading is done. However, the inbreeding coefficients and other population parameters determined for the population in this report are probably accurate.

Inbreeding

Inbreeding is the mating of related animals. The genetic consequences of inbreeding are that an offspring receives the same genes from both parents because the parents are related, and the genes came from a common ancestor. Inbreeding in a population is measured by the probability that both copies of a gene came from a common ancestor. This is called the inbreeding coefficient (F). The inbreeding coefficient will be higher when the relationship between the parents is higher – it depends on how closely they are related and how many ancestors they have in common.

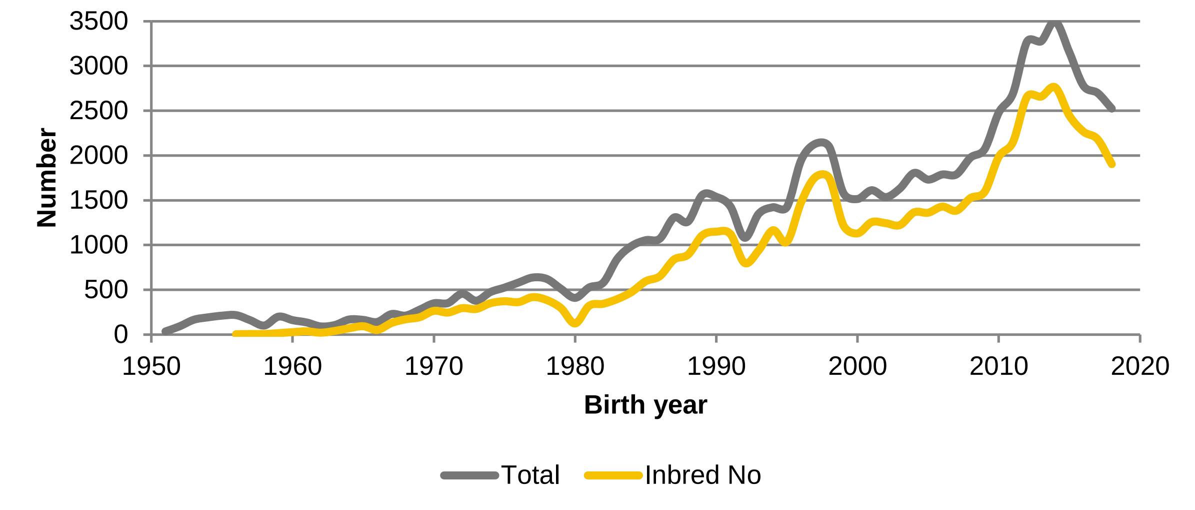
Inbreeding is used in livestock breeding to purify the breed, to concentrate 'good' genes and to increase uniformity in the offspring (Gomez et al., 2008). The danger of inbreeding lies there in that it can gradually decrease productivity, fertility and survivability – a phenomenon known as inbreeding depression. Inbreeding does not affect all traits at the same intensity. Traits associated with fitness (lowly heritable) are affected most, such as survivability, mothering ability, growth and reproduction. It can therefore lead to lower conception rates, more abortions, more stillborn and weak calves and a higher susceptibility to diseases. Generally, the effects of inbreeding can become noticeable at an F value of 0.0625 (6.25%), therefore it is generally recommended that individuals should have inbreeding coefficients of less than 6.25%. The theoretical maximum inbreeding coefficient is 50%. However, it should be noted that not all inbred animals show signs of inbreeding depression.

Figure 8: Average inbreeding



From Figure 8 it can be seen that average inbreeding levels in the Tuli breed has decreased in recent years and are currently below the recommended level of 6.25%, indicating that inbreeding is kept under control in the breed in general. However, the number of inbred animals relative to the total number of animals shows that most animals have some level of inbreeding (Figure 9). It is recommended that inbreeding levels should be kept below 6.25%.

Figure 9: Total and inbred number of Tuli Cattle



Breeders should be advised to avoid mating of closely related animals, so as to keep inbreeding at a low level. Breeders are advised to rather use linebreeding, which is slow inbreeding of distantly related animals in order to fix certain traits within the breed.

Inbreeding that occurs over many generations slowly decreases the number of ancestors represented in the population and genetic diversity therefore decreases (Figure 10). Some valuable genes can be lost during this process. To maintain sufficient genetic diversity in a population, it is recommended that long-term inbreeding should not be more than 0.5 – 1% per generation. Inbreeding in the Tuli population is increasing at 0.08% per generation, which implies that genetic diversity is not at risk in the Tuli breed.

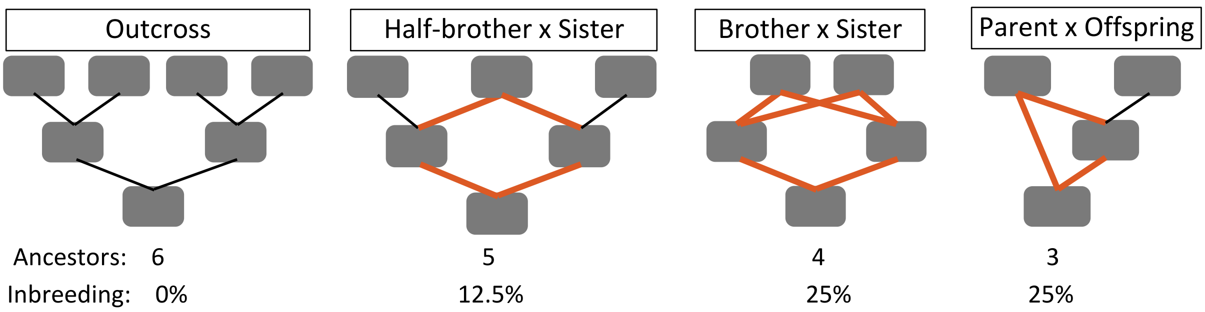


Figure 10: Mating of related animals cause inbreeding to rise and a decrease of the number of ancestors (and genetic diversity). This could lead to a situation where fewer (and only related) animals are available as parents.

Although it is not a problem in the Tuli breed at the moment, breeders should continue to avoid inbreeding. Inbreeding can be avoided by increasing the number of individuals contributing to the next generation. The easiest way to do this is to increase the number of unrelated bulls used as sires. Closely related animals should also not be mated. It is recommended that matings where the bull and cow share more than one common grandparent should be avoided, as the inbreeding coefficient would then be more than 6.25%. This will minimize inbreeding in the short term, but will have no effect if the of animals available as parents, is either too little or too related. In general, limitations should be placed on the level of inbreeding caused by bulls selected into the mating programme.

Effective Population Size

The effective population size (N_e) indicates the genetic size of a population, which is usually smaller that the census size. It is also defined as the effective number of breeding animals or the number of individuals in the population breeding totally at random (Villanueva, 2011). The effective population size is defined as the size of an idealized population which would give rise to the rate of inbreeding in the population under consideration (Wright, 1923). The rate of loss of genetic diversity over time depends on the effective population size which is linked to age structure and mean generation interval of the breeding animals (Engen et al, 2005).

In animal breeding, it is recommended to maintain an effective populations size (N_e) of at least 50 (short-term fitness) to 100 (long-term fitness) that corresponds to a rate of inbreeding of 0.5 to 1% per generation (FAO, 1998, Bijma, 2000). There are various methods to estimate effective population size, and the effective population size of the Tuli population is estimated at 75 to 641 (Groeneveld). The effective population size indicates that long term fitness and therefore long term survival of the breed is probably safe at this stage.

Generation Interval

Generation interval is one of the key factors affecting the rate of genetic progress and therefore the genetic structure of the population. As a general rule, the shorter the generation interval the more rapid is the genetic change in the population holding other factors constant. Generation interval can be defined as the average age of the parents at the birth of their selected offspring (Falconer & Mackay, 1996). In the evaluation of generation interval, an offspring is considered selected if it has produced at least one offspring. The average generation interval for the Tuli population in South Africa is 6.1 years, with 6.2 years for males and 5.9 years for females. This generation interval compares favourably with indigenous South African breeds, which varied between 6.0 and 6.4 years (Abin et al., 2016. SAJAS 46:152).

Family size

It is also important to know how many progeny did parents have and which parents made an important contribution in the breed. However, the total number of progeny per parent is not as important as the number of progeny per parent that were again selected to become parents. Family size refers to the number of offspring of an individual that become breeding individuals in the next generation (Falconer & Mackay, 1996). Progeny per sire ranged between 1 and 671 with an average of 45 (SD 58.2). An average of 15 (SD 20.2) progeny per sire were selected to become parents themselves, ranging between 1 and 196. Cows have on average 4 calves (SD 2.8) ranging between 1 and 19 calves. On average, 2 calves per dam (SD 1.3) will be selected to become parents, ranging between 1 and 13.

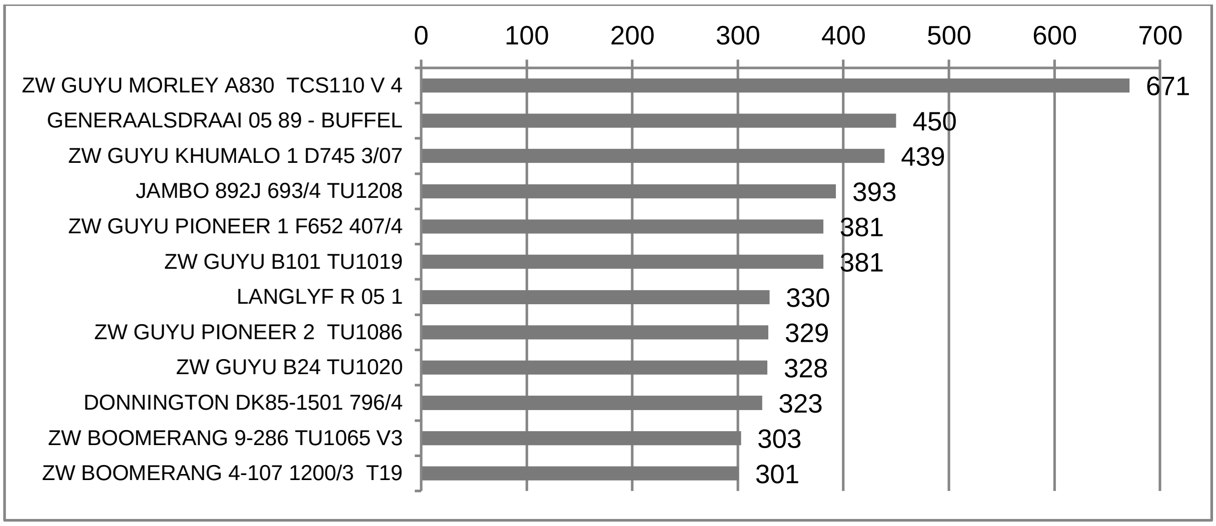
Important animals in the breed

It is also important to identify animals that have made major genetic contributions to the breed. They are identified by the animals with the most offspring in the breed, the most selected offspring in the breed, and the highest Additive Genetic Relationship (AGR) and Genetic Contribution (GC).

Bulls with the most registered calves

There are 12 bulls with more than 300 calves on the South African Logix data base. The Tuli bull with the most calves in the South African population is the Zimbabwean bull GUYU MORLEY, born in 1970. The South African bull with the most registered calves is GENERAALSDRAAI 05 89 – BUFFEL, with 450 registered calves.

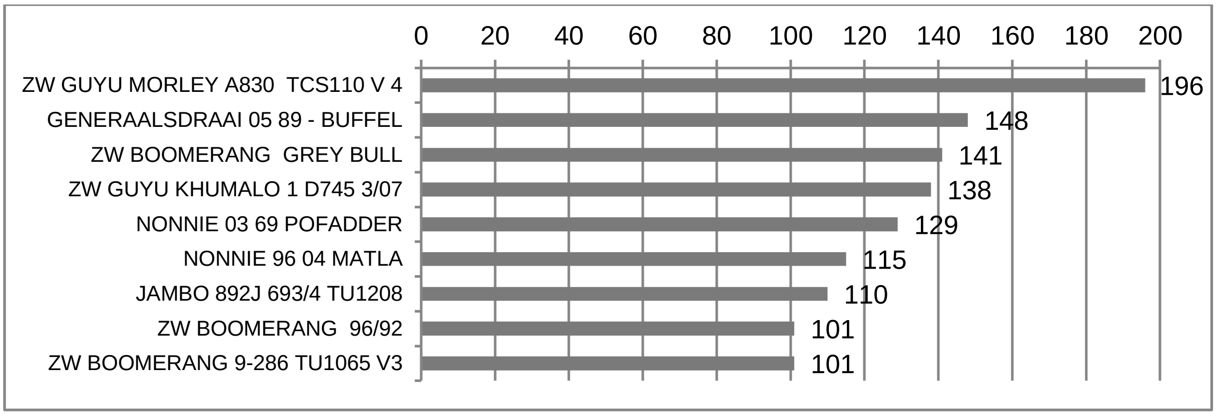
Figure 11: Bulls with the most registered calves.



Bulls with the most offspring selected as parents

Even though a bull may have many registered calves, it does not necessarily mean that he has the largest genetic contribution in the breed, as the number of offspring selected as parents will have a greater influence. The bulls with the most offspring that became parents are as follows:

Figure 12: Bulls with the most registered calves selected to become parents.

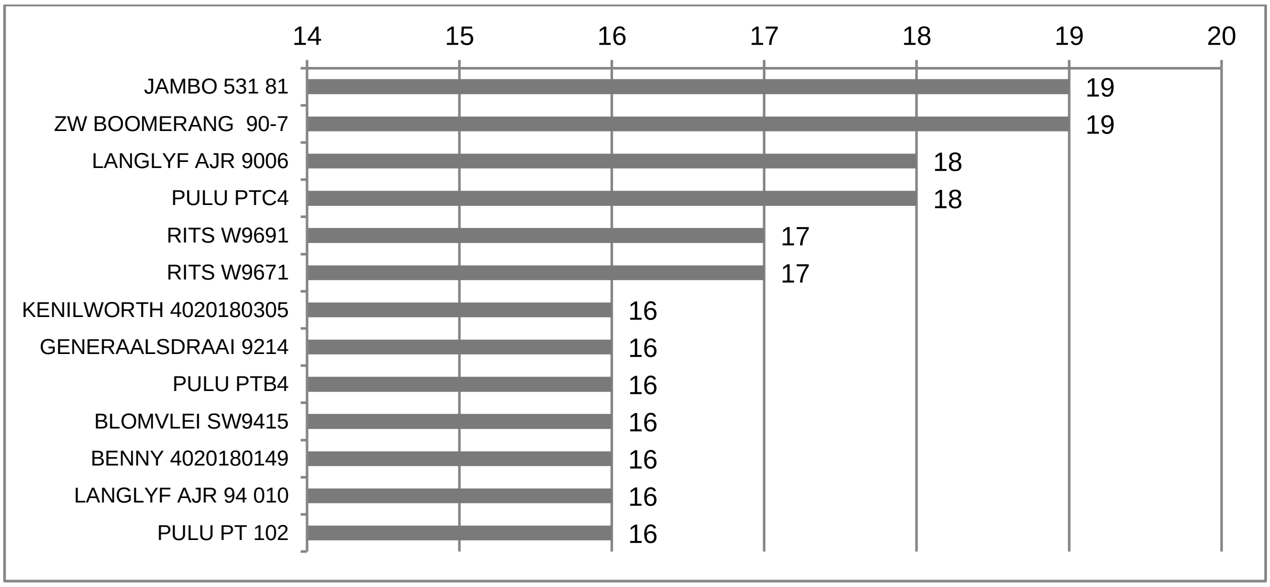


It can be seen that the Tuli bulls with the most registered calves in the South African population is also the two bulls with the most selected progeny, namely GUYU MORLEY, with 196 and GENERAALSDRAAI 05 89 – BUFFEL, with 148 calves.

Cows with the most calves

The longevity and fertility of the Tuli cow is clear in the figure: 13 cows with more than 15 calves each. JAMBO 531 81 and ZW BOOMERANG 90-7 each have 19 calves on record.

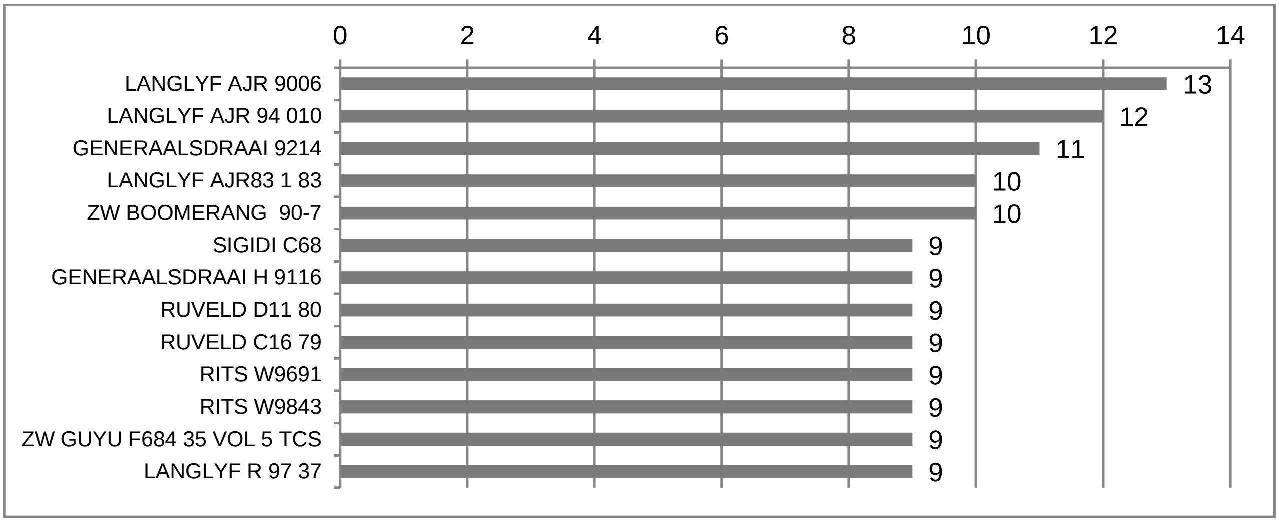
Figure 13: Cows with the most registered calves.



Cows with the most offspring selected as parents

However, the two cows that had the most calves selected to become parents, were the two Langlyf cows AJR 9006 with 13 of her 18 calves becoming parents and AJR 94 010 with 12 of her 16 calves selected as breeding stock.

Figure 14: Cows with the most registered calves that became parents.



Influential animals

The most influential animals in a breed are determined by the Additive Genetic Relationship (AGR) and the Genetic Contribution (GC). Both these scores are related to one another and to the inbreeding of the animal. The official definitions are listed below.

Genetic Contribution (GC)

The proportion of the genes of the calves born in a specific year (2018) that are expected to derive by descent from a **specific ancestor** is known as the genetic contribution of the specific ancestor. It relates to the development of the pedigree over generations and gives an indication of how the ancestor may influence the population. (J. A. Woolliams, P. Bijma, B. Villanueva, 1999. GENETICS 153 (2) 1009-1020). Animals have common ancestors when their common ancestor was popular enough to have multiple offspring, which, possibly after some generations, resulted in the birth of both parents. The more popular a breeding animal was in the past, the larger the chance that two potential parents have this ancestor in common. The more animals share that common ancestor, the larger the chance that mating two animals will result in an inbred offspring. In other words, there is a relation between the long term genetic contribution of an animal to the population and the rate of inbreeding in the population. The genetic contribution is a measure of the level of relatedness between animals in a population because of a shared common ancestor.

The ancestor with the highest GC score is the Zimbabwean bull GUYU GUYU B1 2/1 P1, born nearly 70 years ago in 1951, with a very high GC score of 17.27%. (In most breeds the most influential ancestor's influence is less than 10%). GUYU GUYU is therefore the bull with the single largest influence on the South African Tuli population. The GUYU GUYU line (parents, sons and grandsons) are also well represented. As can be seen from table 1, the South African Tuli calves born in 2018 are still greatly influenced by Zimbabwean genetics, as is expected.

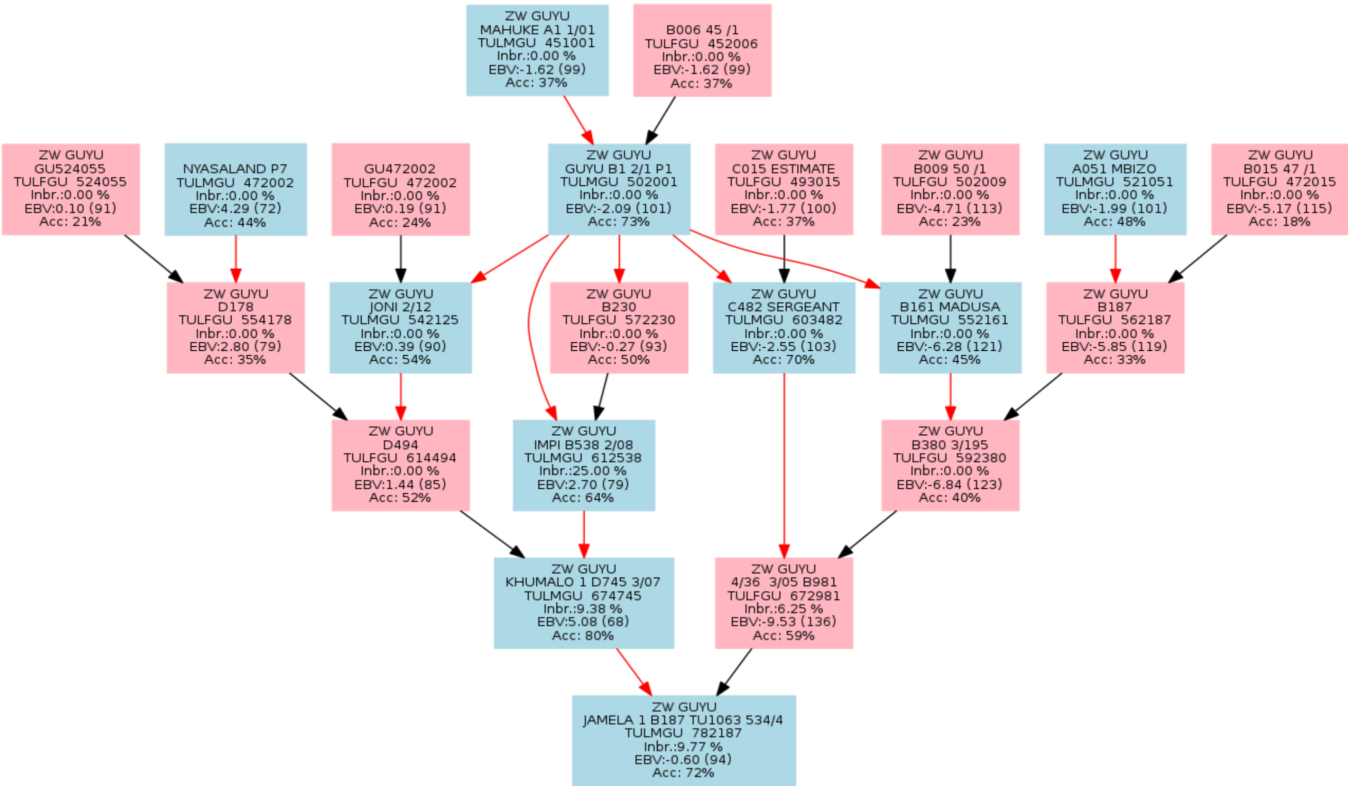
Table 1: Bulls with the highest Genetic Contribution (GC) in the breed.

Animal			Sire		Dam		Inbr. %	AGR	GC
Herd	Name	Sex	Herd	Name	Herd	Name			
ZW GUYU	GUYU B1 2/1 P1	M	ZW GUYU	MAHUKE A1 1/01		B006 45 /1	0	17.28	17.28
ZW GUYU	KHUMALO 1 D745 3/07	M	ZW GUYU	IMPI B538 2/08	ZW GUYU	D494	9.38	18.31	9.86
	B006 45 /1	F					0	8.64	8.64
ZW GUYU	MAHUKE A1 1/01	M					0	8.64	8.64
ZW BOOMERANG	SIZINDA 1 TU1222	M	ZW GUYU	PATCH 1 D457	ZW BOOMERANG	6/220 2249/1	0	9.05	6.55
ZW GUYU	IMPI B538 2/08	M	ZW GUYU	GUYU B1 2/1 P1	ZW GUYU	B230	25	17.37	6.41
ZW GUYU	C482 SERGEANT	M	ZW GUYU	GUYU B1 2/1 P1	ZW GUYU	C015 ESTIMATE	0	13.27	6.18
NONNIE	96 04 MATLA	M	ZW BOOMERANG	930086	NONNIE	CR 93 020	6.92	15.88	5.52
ZW GUYU	JAMELA 1 B187 TU1063 534/4	M	ZW GUYU	KHUMALO 1 D745 3/07	ZW GUYU	4/36 3/05 B981	9.77	17.66	5.47
ZW GUYU	SPUTNIK B461 205	M	ZW GUYU	NATAL B077	ZW GUYU	B091 53 /1	0	9.78	5.32
ZW GUYU	JIMMY D763 21/4	M	ZW GUYU	TRANSKEI D597 3/18	ZW GUYU	D617 4/09	4.69	12.17	5.3
ZW GUYU	CONCORDE B469 5/14	M	ZW GUYU	ROCKET B92 4/123	ZW GUYU	B38	8.2	14.51	5.09

Additive Genetic Relationship (AGR)

The additive genetic relationship reflects what proportion of their DNA (alleles) animals share because they have common ancestor(s). Additive genetic relationships are calculated from the pedigree. In this report, the AGR was estimated relative to Tuli calves born in 2018. The additive genetic relationship is an estimate of the proportion of alleles that the calves born in 2018 have in common because of **one or more common ancestor(s)** (https://wiki.groenkennisnet.nl/*)*. It therefore indicates whether an (older) sire had for example many successful sons that once again formed lines in their own right; or a (younger) sire could have been bred by combining different important lines in his pedigree.

The 50 animals with the highest AGR scores are listed in Table 3 at the back of the report. The most influential animals on the 2018 registered Tuli calves is ZW GUYU KHUMALO 1 D745 3/07 with a very high AGR score of 18.31. His son JAMELA 1 is also highly related to the 2018 born Tuli calves in South Africa.



Pedigree Drawing for JAMELA 1 B187 TU1063 534/4

Figure 15: The pedigree for ZW GUYU JAMELA 1, (son of KHUMALO 1, which is grandson of GUYU GUYU), as on Logix, showing some of the genetics of the early lines in Zimbabwe. The EBVs listed are for Cow Fertility.

Summary

Genetic diversity parameters for the South African Tuli breed.

Trait	Tuli	OK?	Recommen-ded range	Comments
Numbers registered/year	±2500			Decreasing trend
Pedigree completeness	86%	✓	>80%	Genetic diversity and inbreeding estimates are probably correct
Average inbreeding	5%	✓	<6.25%	Decreasing and safe
Rate of inbreeding	0.08%	✓	<0.5-1%	Safe
Effective population size: **Short term survival** **Long term survival**	 75 - 641	 ✓ ✓	 >50 >100	Current effective population size is within safe limits for long time survival
Generation interval	6.1 years	✓	6.0-6.4	Average
Age Structure: Sires **(avg age) : Dams**	5.8 years 5.3 years	✓ ✓		
Family size*: Sires **Dams**	45(671) / 15(196) 4(19)/2(13)	✓ ✓		
Sire with most progeny	671			GUYU MORLEY A830 TCS110 V 4
Sire with most selected progeny	196			GUYU MORLEY A830 TCS110 V 4
Dams with most progeny	19			JAMBO 531 81 ZW BOOMERANG 90-7
Dams with most selected progeny	13			LANGLYF AJR 9006 LANGLYF AJR 94 010
Highest AGR (Additive Genetic Relationship)	18.31			ZW GUYU KHUMALO 1 D745 3/07
Highest GC (Genetic Contribution)	17.28			ZW GUYU GUYU B1 2/1 P1

*Family size: Average number of calves per parent (max number of calves) / average number of calves selected to become parents (max number of selected calves)

The genetic diversity parameters for the South African Tuli population are all well within safe limits. Around 2500 calves per year are registered. As pedigree completeness is generally high (>80%), genetic diversity parameters using pedigree information for the Tuli breed could be accurately estimated. The average inbreeding, rate of inbreeding, effective population size and generation interval are well within recommended levels. AGR and GC scores are however very high and dominated by Zimbabwean genetics and more specific the Guyu Guyu line, as is to be expected. The breed has a high rate of performance measurement, therefore ensuring continued selection for efficient animals.

Table 3: Tuli ancestors with the highest AGR (Additive Genetic Relationship) to the 2524 registered calves born in 2018. GC score (Genetic Contribution) as well as Inbreeding (F %) are also shown.

Animal						Sire			Dam			F %	AGR	GC
No	**Herd**	**Name**	**ID**	**Birth year**	**Sex**	**Herd**	**Name**	**ID**	**Herd**	**Name**	**ID**			
1	ZW GUYU	KHUMALO 1 D745 3/07	GU 674745	1967	M	ZW GUYU	IMPI B538 2/08	GU 612538	ZW GUYU	D494	GU 614494	9.38	18.31	9.86
2	ZW GUYU	JAMELA 1 B187 TU1063 534/4	GU 782187	1978	M	ZW GUYU	KHUMALO 1 D745 3/07	GU 674745	ZW GUYU	4/36 3/05 B981	GU 672981	9.77	17.66	5.47
3	ZW GUYU	IMPI B538 2/08	GU 612538	1961	M	ZW GUYU	GUYU B1 2/1 P1	GU 502001	ZW GUYU	B230	GU 572230	25	17.37	6.41
4	ZW GUYU	GUYU B1 2/1 P1	GU 502001	1951	M	ZW GUYU	MAHUKE A1 1/01	GU 451001		B006 45 /1	GU 452006	0	17.28	17.28
5	ZW BOOMERANG	RED BULL 108 861/4 TU1484	BG 850108	1985	M	ZW GUYU	JAMELA 1 B187 TU1063 534/4	GU 782187	ZW BOOMERANG	8-147 TU378 803/3	BG 780147	9.03	16.18	3.49
6	NONNIE	96 04 MATLA	CR 960004	1996	M	ZW BOOMERANG	930086	BG 930086	NONNIE	CR 93 020	CR 930020	6.92	15.88	5.52
7	ZW GUYU	KIMBINI 2 A84	GU 751084	1975	M	ZW GUYU	KIMBINI 1 B220 5/25	GU 702220	ZW GUYU	A782 4/190	GU 691782	12.6	15.09	2.35
8	ZW BOOMERANG	GREY BULL	BG 890060	1989	M	ZW GUYU	JAMELA 1 B187 TU1063 534/4	GU 782187	ZW BOOMERANG	78-37	BG 780037	6.49	15.02	3.31
9	ZW BOOMERANG	930086	BG 930086	1993	M	ZW BOOMERANG	RED BULL 108 861/4 TU1484	BG 850108	ZW BOOMERANG	8838	BG 880038	8.29	14.8	3.17
10	ZW GUYU	CONCORDE B469 5/14	GU 722469	1973	M	ZW GUYU	ROCKET B92 4/123	GU 692092	ZW GUYU	B38	GU 682038	8.2	14.51	5.09
11	ZW GUYU	SIGIDI B748 4/349	GU 752748	1975	M	ZW GUYU	KHUMALO 1 D745 3/07	GU 674745	ZW GUYU	B999 3/243	GU 672999	3.91	13.97	2.62
12	WALTERTON	8707	SJB 870007	1987	M	WALTERTON	83005 83	SJB 830005	RUVELD	E114 81	MSB 810114	9.36	13.46	2.23
13	GENERAALSDRAAI	03 73	H 030073	2003	M	NONNIE	9935	CR 990035	GENERAALSDRAAI	95 49	H 950049	7.55	13.32	2.2
14	ZW GUYU	C482 SERGEANT	GU 603482	1961	M	ZW GUYU	GUYU B1 2/1 P1	GU 502001	ZW GUYU	C015 ESTIMATE	GU 493015	0	13.27	6.18
15	GENERAALSDRAAI	05 89 - BUFFEL	H 050089	2005	M	GENERAALSDRAAI	99 22	H 990022	GENERAALSDRAAI	98 36	H 980036	3.86	12.9	4.66
16	ZW BOOMERANG	96/92	BG 960092	1996	M	ZW BOOMERANG	AFRICA 1 TU2363	BG 900090	ZW BOOMERANG	91-97	BG 910097	8.64	12.82	2.21
17	LARYN	96 55	JM 960055	1996	M	SIGIDI	S56	HKL 920056	LARYN	JM 9121	JM 910021	6.53	12.77	2.77
18	NONNIE	98 30 BOBATSI	CR 980030	1998	M	NONNIE	CR 95 008	CR 950008	LANGLYF	AJR 87 33	AJR 870033	4.8	12.36	3.16
19	ZW GUYU	ROCKET B92 4/123	GU 692092	1969	M	ZW GUYU	GENERAL B827 3/04	GU 642827	ZW GUYU	GU 652863	GU 652863	3.91	12.28	3.44
20	ZW GUYU	JIMMY D763 21/4	GU 674763	1967	M	ZW GUYU	TRANSKEI D597 3/18	GU 634597	ZW GUYU	D617 4/09	GU 644617	4.69	12.17	5.3
21	ZW GUYU	B38	GU 682038	1968	F	ZW GUYU	C482 SERGEANT	GU 603482	ZW GUYU	B783 222/3	GU 642783	9.38	11.99	2.55
22	ZW GUYU	4/36 3/05 B981	GU 672981	1967	F	ZW GUYU	C482 SERGEANT	GU 603482	ZW GUYU	B380 3/195	GU 592380	6.25	11.96	3.61
23	ZW BOOMERANG	80-22 80	BG 800022	1980	M	ZW GUYU	CONCORDE B469 5/14	GU 722469	ZW BOOMERANG	72-26	BG 720026	4	11.95	2.21
24	NONNIE	CR 93 020	CR 930020	1993	F	ZW BOOMERANG	8721BG TU1745	BG 870021	LANGLYF	AJR 89 48	AJR 890048	3.08	11.75	2.76

Animal						Sire			Dam			F %	AGR	GC
No	Herd	Name	ID	Birth year	Sex	Herd	Name	ID	Herd	Name	ID			
25	GENERAALSDRAAI	99 22	H 990022	1999	M	NONNIE	CR 92 018	CR 920018		JAMBO 1618	J 911618	4.13	11.62	2.4
26	ZW GUYU	JONI 2/12	GU 542125	1955	M	ZW GUYU	GUYU B1 2/1 P1	GU 502001		GU472002	GU 472002	0	11.28	3.52
27	ZW GUYU	B230	GU 572230	1957	F	ZW GUYU	GUYU B1 2/1 P1	GU 502001				0	11.04	3.21
28	ZW GUYU	NATAL B077	GU 532077	1953	M	ZW GUYU	GUYU B1 2/1 P1	GU 502001	ZW GUYU	B001 50 /1	GU 502001	0	11.04	3.2
29	ZW GUYU	D617 4/09	GU 644617	1964	F	ZW GUYU	C482 SERGEANT	GU 603482	ZW GUYU	D178	GU 554178	0	10.82	3.34
30	ZW GUYU	D494	GU 614494	1961	F	ZW GUYU	JONI 2/12	GU 542125	ZW GUYU	D178	GU 554178	0	10.64	4.95
31	WALTERTON	83005 83	SJB 830005	1983	M	ZW GUYU	C969 2/926	GU 753969	ZW GUYU	E249	GU 765249	8.03	10.55	2.17
32	ZW GUYU	GU 572244	GU 572244	1957	M	ZW GUYU	GUYU B1 2/1 P1	GU 502001	ZW GUYU	B024 49 /2	GU 492024	0	10.34	2.26
33	ZW BOOMERANG	96/53	BG 960053	1996	M	ZW BOOMERANG	MANGENA TU2236	BG 870120	ZW BOOMERANG	90-16	BG 900016	3.65	10.27	2.87
34	ZW GUYU	MORLEY A830 TCS110 V 4	GU 701830	1970	M	ZW GUYU	B853 CETZWAYO 3/355	GU 652853	ZW GUYU	A594 3/164	GU 641594	4.69	10.19	2.53
35	ZW GUYU	SPUTNIK B461 205	GU 602461	1960	M	ZW GUYU	NATAL B077	GU 532077	ZW GUYU	B091 53 /1	GU 532091	0	9.78	5.32
36	GENERAALSDRAAI	98 36	H 980036	1998	F		LEBAR Q63	LB 950063	GENERAALSDRAAI	H9592	H 950092	3.27	9.69	2.63
37	ZW BOOMERANG	85-13	BG 850013	1985	M	ZW BOOMERANG	SIZINDA 1 TU1222	BG 760003	ZW BOOMERANG	77-82 2/1102	BG 770082	0.78	9.36	2.58
38	ZW BOOMERANG	78-37	BG 780037	1978	F	ZW GUYU	CONCORDE B469 5/14	GU 722469	ZW BOOMERANG		BG 670045	0	9.23	2.71
39	ZW BOOMERANG	SIZINDA 1 TU1222	BG 760003	1976	M	ZW GUYU	PATCH 1 D457	GU 614457	ZW BOOMERANG	6/220 2249/1	BG 660220	0	9.05	6.55
40	LANGLYF	AJR 87 33	AJR 870033	1987	F	ZW GUYU	CONRAD 2 D316	GU 774316	ZW KOCE	HYN017	HT 800017	0	8.78	2.36
41		B006 45 /1	GU 452006	1945	F							0	8.64	8.64
42	ZW GUYU	MAHUKE A1 1/01	GU 451001	1945	M							0	8.64	8.64
43	ZW GUYU	TRANSKEI D597 3/18	GU 634597	1964	M	ZW GUYU	GU 572244	GU 572244	ZW GUYU	D261 19/3	GU 574261	0	8.23	2.8
44	ZW GUYU	PATCH 1 D457	GU 614457	1961	M	ZW GUYU	GUANA A226 2/11	GU 571226	ZW GUYU	D10	GU 484010	0	8.15	4.08
45	ZW GUYU	D178	GU 554178	1955	F		NYASALAND P7	GU 472002	ZW GUYU	GU524055	GU 524055	0	5.04	4.15
46	ZW GUYU	A051 MBIZO	GU 521051	1953	M		NYASALAND P7	GU 472002		A020 49 /1	GU 491020	0	3.97	2.7
47		NYASALAND P7	GU 472002	1947	M	GUYU	MARUPISI	GU 451003		B013 45/1	GU 452013	0	3.86	3.86
48	ZW BOOMERANG	6/220 2249/1	BG 660220	1967	F							0	3.4	3.4
49	ZW GUYU	B091 53 /1	GU 532091	1953	F							0	3.19	3.19
50	ZW GUYU	C015 ESTIMATE	GU 493015	1949	F							0	3.09	3.09