Project title:
Sustainable development of semi-arid grassland utilsation through optimised management of stock densities, recovery periods and carring capacity of organic cattle and sheep farming on the example of Springbockvley, Namibia

Project partner:
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Concept date:
March 2014

Problem:
Livestock farming in the vast grazing areas in Namibia partly shows **severe management deficiencies**, resource inefficiency, low food security levels, low profitability, loss of biodiversity, a strong negative climate impact, soil degradation and slow regional and national development (IAASTD, 2009; Mills & Fey, 2005). Given the prominent role of herbivore livestock in grasslands, livestock must be addressed explicitly as a **a) source of products** such as meat, milk, hide, wool, fuel, manure and

social security (Fresco and Steinfeld, 1998) and **b) as a major factor of ecological impact** on the soils, the water and the vegetation of the pastures, which supply > 90% of livestock feed in the grassland-based livestock systems (Seré & Steinfeld, 1996).

Today in Namibia, livestock is kept in **fenced pastures on ranches**, herded on communal farmland, or kept as free roaming livestock close to the settlements (Homann & van Rooyen, 2007a). Controlled livestock grazing on ranches is usually done at low stocking rates (10-20 ha LU^{-1}) and animals are opportunistically shifted to new areas when the feed is finished. **Desertification** remains a key threat to the region.

A **major problem** for grassland productivity in savanna rangelands is the **absence of recovery periods**: cattle graze the same areas year round, resulting in perennial grasses being replaced by annuals (Prins & Van der Jeugd, 1993; Fynn, 2012). Insufficient recovery periods lead to reduced productivity and eventual death of the plant (Kirkmann & Moore, 1995). This facilitates **shrub and tree encroachment** (Danckwerts et al., 1989; Rogues et al., 2001), which in turn further **reduces grassland productivity** through effects of shading and competition for soil moisture – a **negative feedback on grassland productivity and carrying capacity**. Over-utilized/non-rested pastures show "bare soil", and become degraded (wind and water erosion). On under-utilized/over-rested pastures the – mainly annual – grass sward can grow, seed and die without livestock and/or game impact, exhibiting bare soil with capping between grass stands. This dead, oxidized grass has a low feed value and is not eaten by herbivores. In the case of uncontrolled grazing this degradation is even worse, because livestock does not shift to better feeding areas on their own (degradation gradients from watering places and kraals/villages) (Homann & van Rooyen, 2007ab; Rietkerk et al., 2000).

Inproved grazing systems with high stock densities do impact through trampling, defoliation of plants, and excretion, influence water and nutrient flux processes and parameters, and thus overall grassland productivity. This does result in more biomass and last but not least in higher meat productivity or less risk in the case of drought. The sustainable impact is the C-fixation potential, soil nutrient and organic matter concentrations, soil bulk density, surface texture and micro-relief (Belsky, 1984; Hiernaux et al., 1999; Wezel & Schlecht, 2004). Trampling breaks up silted soil surfaces, improves water infiltration and seed germination and destroys un-grazed grass stands (Proulx & Mazumder, 1998). This impact varies in its spatial-temporal distribution and intensity depending on stocking densities (short term) and stocking rates (long term), herd composition (livestock species, animal categories by age and physiological status), herding patterns and strategies, herd mobility and quality, and amount of supplementary feeding (Dickhoefer et al., 2010; Schlecht et al., 2006; Schlecht et al., 2010; Turner et al., 2005).

Goal:
Questions for the research are:

1. Which methodology is suitable to measure biomass production and grazing days?
2. How does the changing of stock densities (TLU/ha) influence biomass production?
3. How does the changing of stocking rates (TLU/ha/a) influence biomass production?

Methodology

Different stocking densities and stocking rates of a 800 head cattle herd and 3,500 head sheep flock on the 9,500 ha rangeland farm Springbockvley in Namibian Organic will be taken as starting point to assess and develop sustainable stock densities and stocking rates on grassland in Namibia. The farm is managed according to the Holistic Management (HM) principles since 1990. Because of the special herd management the stocking rate, biomass production and last but not least the meat production per ha and year has changed in the last years significantly (Table 1).

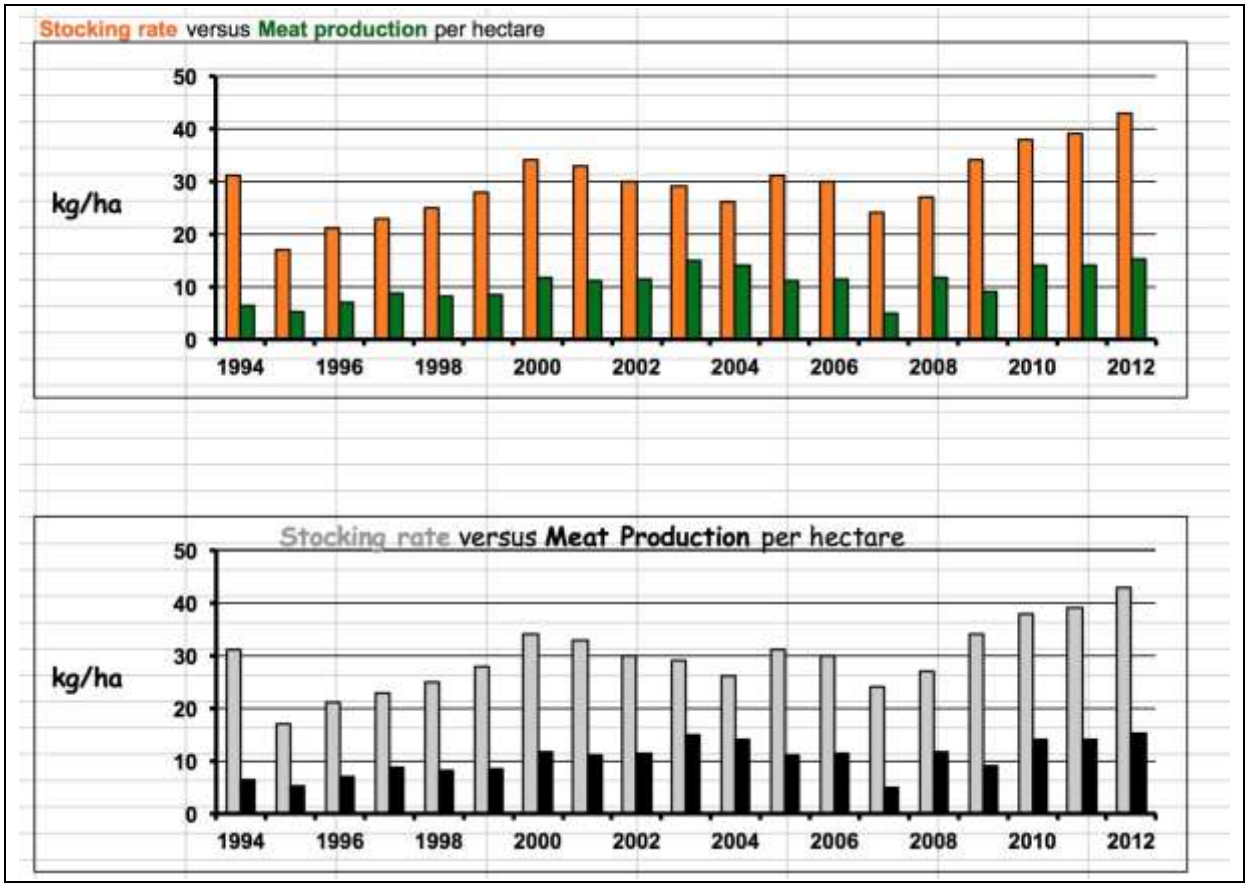


Table 1: Changed stocking rate and meat production in the last 20 years with Holistic Management

In 2013, Springbockvley has received the lable as organic farm (Namibian Organic) and changed the old management system (4 herds rotated in 4 farm sections) into a full farm rotation with 3 herds (see figure 1). This has increased not the stocking rate, but the stocking density (about 133% compared to the conditions before 2013). The expected impact is further increase of biomass production, consequently an increase in carrying capacity and thus ultimately more meat production per ha, or, alternatively higher stability in the case of droughts (more fodder available for dry periods).

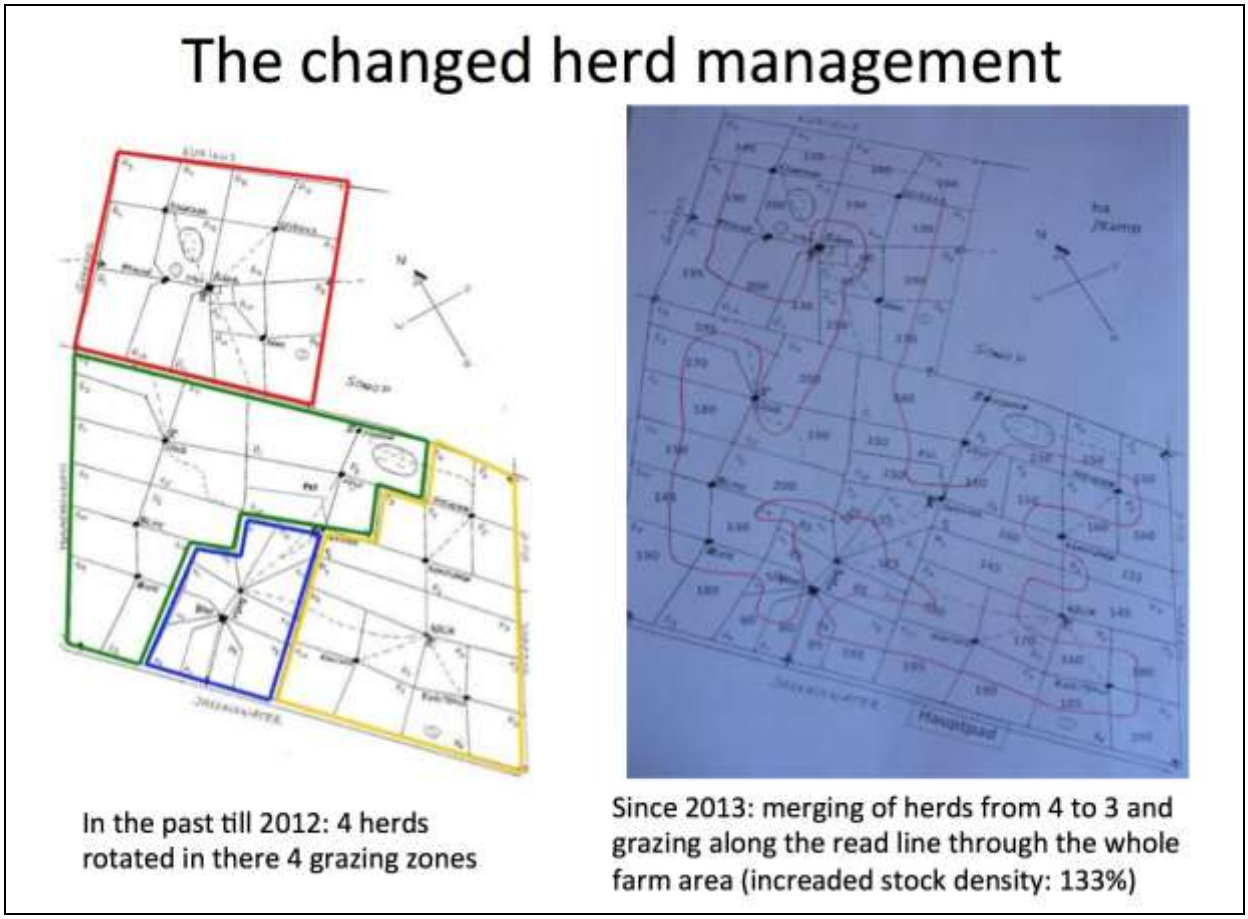


Figure 1: Old and changed grazing system

All 3 herds will follow the „red grazing line“ on the farm and will give recovery/resting periods between 60 and 100 days. That means, that every herd/flock will have grazed every paddock approximately 1,3 times a year.
Grazing plans are drawn up according to Holistic Management Grazing Planning after an annual estimation of animal consumable biomass (grazing days /ha) for every paddock using the STAC method (In Practice Magazine – Quelle folgt).

For the project two variations will be integrated:

1. Increased stocking density (The paddock will be subdivided with a mobile electric fence into a number of parcels equivalent to the estimated grazing days. Every day a new parcel will be opened for the herd to graze. Portionsweide.)
2. Increased stocking rate (The paddock will be grazed for twice the duration of estimated grazing days.)

These variations will be compared with the current system of stock density and stocking rate. For these experiments, 4 replications have been selected on the farm (Figure 2, Table 2). The goal of the research is to prove if these changes can be measured scientifically.

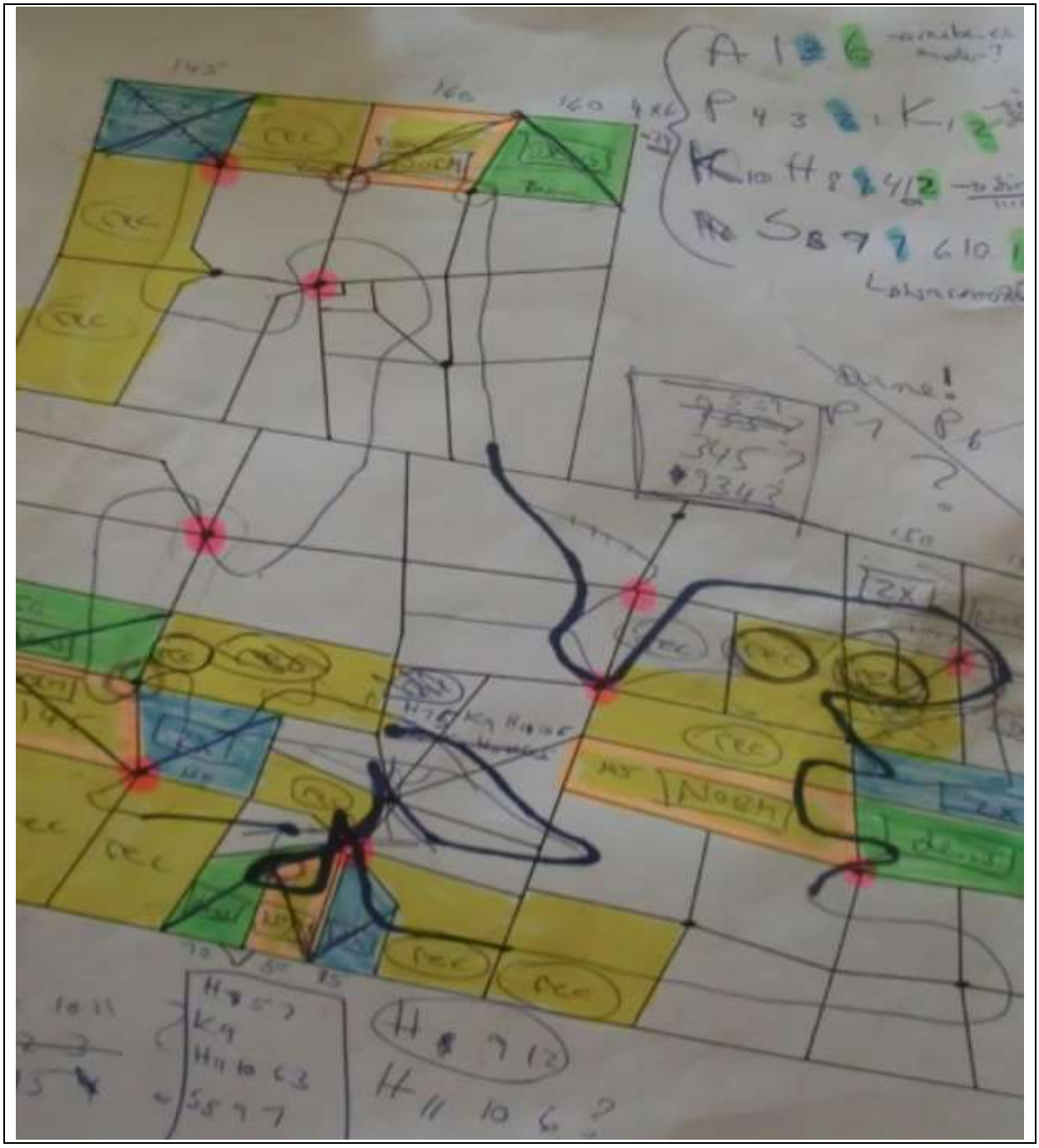


Figure 2: Selected experimental plots (4 replications with 3 plots each)

Table 2: Plot number for experiments (GPS see attachment)

	Control (current system)	Increased stocking density (bunch grazing with mobile electric fence)	Increased stocking rate (twice current stocking rate)
Replication 1: House	H 1 (80 ha)	H 2 (90 ha)	H 9 (95 ha)
Replication 2: Sand	S 10 (145 ha)	S 11 (150 ha)	S 7 (130 ha)
Replication 3: Achab	A 5 (160 ha)	A 6 (160 ha)	A 3 (145 ha)
Replication 4: Pan	P 3 (150 ha)	P 4 (160 ha)	P 9 (150 ha)

The experiment will be done for 3 years, from May 2014 to May 2017.

A) Grazing management for experiments

The variation of the herd management will be done while the routine grazing modus, following the „red line". There will be no fixing of the date, when the herds enter the paddock. The herds will enter each paddock in compliance with the grazing plan designed as per description above. The fodder availability expressed in grazing days per ha will be assessed in May of each year. The selected paddocks will be managed according to the grazing plan, and this will be assessed. The „red line" has been modified so that the herds/flocks will always graze two normal paddocks (managed according to the current grazing regime) before they enter a treatment paddock (increased density or double stocking rate). This is deemed necessary as an adaptation period for the animals before entering treatment. The second of the normal paddocks between two treatments serves as control (cf. Table and map above).
Example:
Starting replication 1: House:

->

1. normal grazing (no measurement): paddock K10 (400 cows grazing for 6 days on 195 ha.)
   ->
2. normal grazing (no measurement): paddock H8 (400 cows grazing for 6 days on 195 ha)
   ->
3. Double stocking rate (measurement): paddock H9 (400 cows grazing for 3 days x 2=6 days on 95 ha.)
   ->
4. normal grazing (no measurement): paddock H4 (400 cows grazing for 3 days on 85 ha.)
   ->
5. normal grazing (control/measurement): paddock H1 (400 cows grazing for 3 days on 80 ha.)
   ->
6. High density grazing (measurement): paddock H2 (400 cows grazing for 3 days on 90 ha divided into 3 parcels of 30 ha each, alotted on a daily basis using a mobile front and back electric fence.)
   ->
7. The herd will follow the normal grazing routine along the red line until it enters replication 2: Sand, and so on.

B) Livestock assessment

1. All cattle are weighed once every year during the compulsory vaccination routine (Anthrax, Brucella).
2. The livestock is weighed always while they are close to the weigh scale (water point Mahali, 500 m east of farm house).
   a. All cattle will be weighed.
   b. A randomly selected group of sheep will be weighed: clustered by age and function (lambs <6 months; lambs 6-12 months; adult sheep > 1 year). The

average number per group should be 50 animals. The result is assumed to be the average weight of all the other sheep in that respective same cluster.

c. All cattle and sheep will be estimated in liveweight as soon as they enter the experimental paddocks (Table 2) to have the most accurate liveweight of the herds.
d. The wild game will be assessed for the experimental paddocks (in estimated kg liveweight).
e. All routinely gathered weight data of livestock (liveweight, carcass weight, birth weights) will be included in the data base to improve the data as much as possible.
f. Births weights of calves and lambs will be recorded randomly (50 calves and 200 lambs per season).

3. All livestock records will be included in the study: losses, sales and purchases, livestock diseases, treatments, calvings, etc. .

C) Vegetation assessment

The main proof of the herd management will be on the assessment of the vegetation. Because it is not clear, which methodology of biomass measurements can be used, a tool test (methodology assessment) has been included in the study. Five different methodologies have been choosen for comparison:

1. **Platemeter test:** Transect walk with a platemeter on all treatment and control paddocks.
   How and when to be done: every May from corner to the opposite (diagonal) corner (between 1 and 2 km), every 2nd step one measurement. The transect will be done every year at the same time (May) and the interannual comparison of the „average biomass hight" will be the indication of growth and biomass.
2. **Vegetation cut test**: on 200 m randomly choosen transect, not closer than 100 m from the paddock fences or other unusual parts of the paddock. (Name der Methode und Vorgehensweise: einfügen Christian)
   How and when to be done: Every 20 m a 1m2 vegetation cut (10 samples per plot) will be done and can be assessed (biodiversity, biomass, feeding value). This will be done every May.
3. **Biomass and coverage estimation test**: on a 50x50 m (2500 m2) permanently defined and marked „Estimation"-parcel (minimum 100 m apart from the paddock fence and special parts of the paddock) the methodologies of
   a. „Klapp" (Biodiversity and biomass estimation combined with special values: feeding value, grazing tolerance etc) and
   b. „Braun Blanquet" (Biodiversity and coverage of vegetation, bare land and dead material).

   How and when to be done: These methodologies will be done according to international standards of grassland estimations. The assessment will be done every May and just before and after each grazing event of the the treatment and control paddocks.
4. **Transect test**: on a 200 m quadrat line (the borders of the parcels in test 3) qualitative biomass assessment (occurrence and abundance of plant species) will be

assessed.
How and when to be done: Every meter along the 200 m line the

a. alive plant,
b. dead plant,
c. litter and
d. bare soil

will be assessed (what does the line touch on ground every m?). This will be done in May.

5. **Picture test**: every year, a transect line (test 3) picture will be done. Comparison over the years.
   How and when to be done: Every May and before and after the grazing a picture is taken always from the main marking pole in the direction of the two adjacent marking poles (50 m distance).

The comparison of these 5 very different vegetation tests is assumed to allow answers about the best, cheapest and most usuable measure (also for farmers) to assess the vegetation coverage, biomass and grazing days estimations:

	Advantage	Disadvantage
Platemeter	• Fast done • Easy to be done • Cheap to be done • The whole plot will be observed and measured (avoiding hotspots and wrong choosen spatial selections) • Objective in results • Internationally done (in NZ, DE, USA)	• No calibration for savanna conditions • Heterogenity of vegetation on the plots • Heterogenity of the season on biomass dryness (platemeter will give different results for the same vegetation but different seasons)
Vegetation cut test	• Exact results about the biodiversity, biomass and feeding value with samples (not only assuming) • Easy to be done (sample taking) • Assessment can be done after sample taking	• Difficult to assess (specialists) • Very expensive to assess • Time consuming to assess • Not clear, if the choosen 200 m transect and the 10 1m2 plots are enough to give information about biomass change through the experiments. • Bushes and trees are not considered
Biomass and coverage estimation test	• Fast to be done • Very cheap (no costs) • On selected parcels of the plots with high data value • Already a chance to have a feeding value (feeding days) with one observation. • Trees and bushes are considered	• Only estimations (more or less as good as the estimations are done; the same methodology as farmers do, but more structured and replicable through written and proofed methodology)

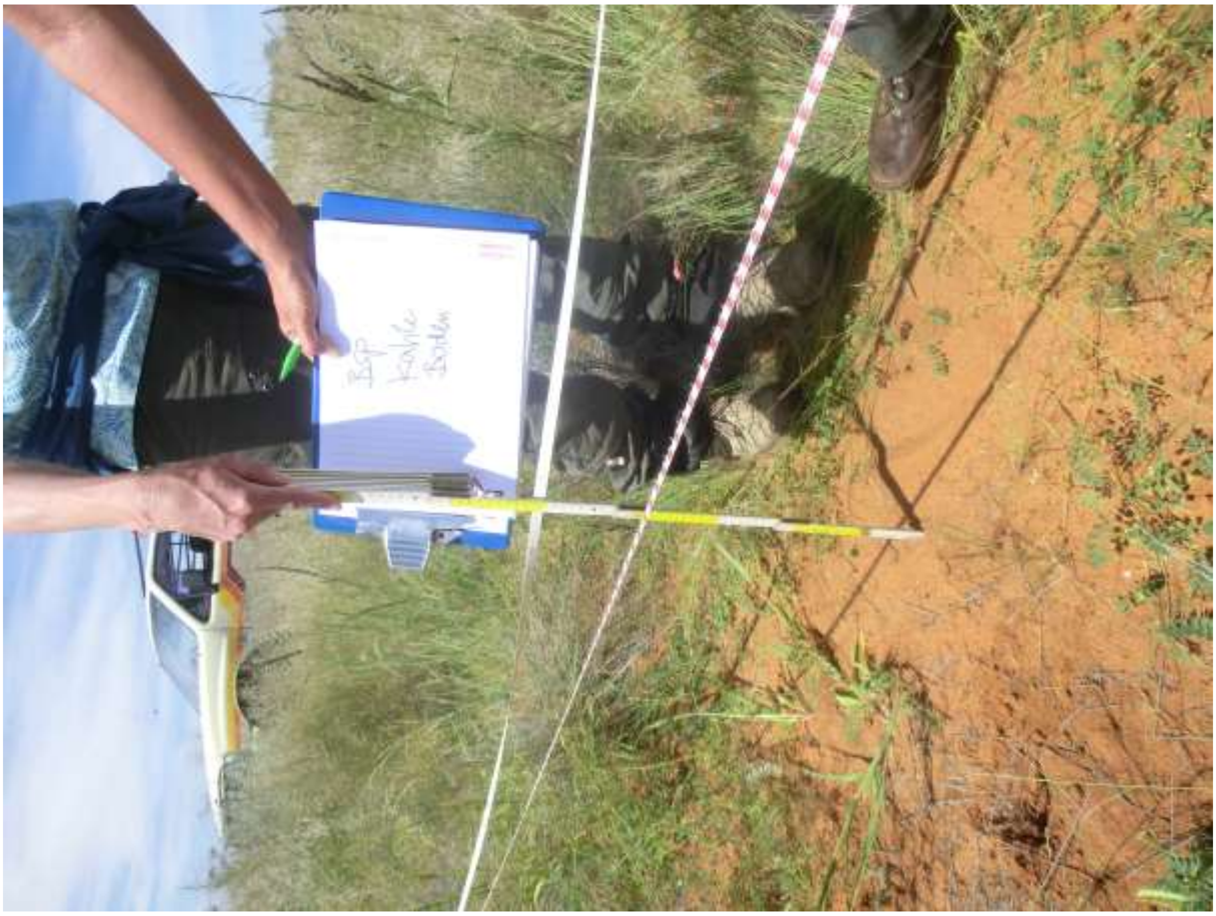
Transect test	• Cheap to be done • Easy to be done • Immediatly results • Replicable results (standard procedure with aibility of replication through perment transect line).	• No information for biomass • Probably not enough info about correct coverage (not enough measurement units – 200). • Trees and bushes are not considered.
Picture test	• Easy to be done • Fast to be done. • Picture give good impressions for long term changes	• Difficult to assess little (short term) changes in vegetation • Not possible to assess scientifically (resp. very difficult). • You need a good camera

There will be every May and/or August of the 3 data gathering years support from Rahmann and/or Hülsebusch for data collection and discussion of the results of the previous year for about one week on Springbockvley.

Measurement pictures:


BSP.
ARISTIDA
LEGEND

BSP
Kraut
Regenwasse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Data sheet vegetation swart/feed assessment „Klapp“ and Braun-Blanquet

Date: _____ Monitoring plot: _____ Name: _____

Covering ration (see methodology):

	%	Average high (cm)
Gras:		
Herbs:		
Bushes (browable):		
Trees (not browseable):		
Bare soil:		
Litter:		

Plants species:

	% of vegetation biomass (Klapp)*	Vegetation covering (Braun-Blanquet) **	Phaenology (f=flowering, g=growing, d=dry)	Average high (cm)
Gras species:				
Herb species:				
Bushes (browseable <2m):	Condition %***	High (max 2m) cm	Width cm	Length cm

Remarks about the plot condition (previous utilisation, swart condition, wild game, etc.):

_____

_____

_____

_____

Methodology:

The assessment plots are 2500 m2 (50m x 50m). They will be assessed always in May and before and after grazing with documentation of number of livestock and grazing days..

How to do joint assessent of Abundanz and Dominanz (Braun-Blanquet) and Biomass and feed quality (Klapp):
(best would be, that two persons do it together and using the data sheet)

1. Going into the plot and identify all vegetation species (gras, herbs, legumes, bushes, trees) and document them as name in the data shet.
2. The walk should cover the whole plot in both diagonale transects and a roaming walk (snake line) from border to border (4x).
3. After the walk all identified plants will be assessed:
   - * **Braun-Blanquet**: Abundanz und Dominanz-Bewertung: 5=>75% coverage, 4=50-75%, 3=25-50, 2=5-25%, 1=>5% (many individues) or >5% (few individues), 0.5=low coverage, few individues, 0.1=very little coverage and very few individues.
   - ****Klapp**: Estimation of biomass of the species (edable roughage: grass, herbs, bushes); total sum must be 100%.
   - *** **Bushes**: condition: 0% = totaly dead ... 100% alive (full of leaves etc). High/width/length: using a measuring instrument to make a cubical (volume in m3), high is measured up to 2 m (assessable feed).
   -
4. After vegetation species assessment the total plot coverage including bare soils and litter will be assessed.

GPS codes for the field trial test plots

GPS Namibia (Springbockvley) field blocks for Klapp assessment (50mx50m):

Replication:	Plot	Number GPS GR	S	E
1	H1	22	2318432	1817874
1	H1	23	2318423	1817901
1	H1	24	2318447	1817914
1	H1	25	2318456	1817886
1	H2	26	2318265	1817719
1	H2	27	2318255	1817719
1	H2	28	2318278	1817701
1	H2	29	2318293	1817726
1	H9	30	2318102	1817504
1	H9	31	2318108	1817480
1	H9	32	2318081	1817478
1	H9	33	2318081	1817506
2	S10	34	2317300	1817804
2	S10	35	2317283	1817826
2	S10	36	2317304	1817843
2	S10	37	2317320	1817820
2	S11	38	2316840	1817424
2	S11	39	2316815	1817437
2	S11	40	2316829	1817464
2	S11	41	2316853	1817448
2	S7	42	2316218	1817668
2	S7	43	2316231	1817694
2	S7	44	2316254	1817681
2	S7	45	2316241	1817655
3	A5	46	2313395	1820308
3	A5	47	2313416	1820328
3	A5	48	2313434	1820310
3	A5	49	2313415	1820288
3	A6	50	2314274	1821293
3	A6	51	2314289	1821317
3	A6	52	2314313	1821304
3	A6	53	2314297	1821279
3	A3	54	2314751	1821911
3	A3	55	2314767	1821934

3	A3	56	2314787	1821913
3	A3	57	2314770	1821889
4	P3	58	2317932	1820337
4	P3	59	2317959	1820341
4	P3	60	2317960	1820312
4	P3	61	2317934	1820308
4	P4	62	2318760	1820626
4	P4	63	2318740	1820645
4	P4	64	2318758	1820667
4	P4	65	2318778	1820648
4	P9	66	2319013	1821145
4	P9	67	2318986	1821149
4	P9	68	2318992	1821179
4	P9	69	2319018	1821174