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Breed-specific classification potentials of sheep in different grassland biotopes

Abstract
There has been an increasing influx from national and international genetic reservoirs into a region that used to be a main breeding area of a merino breed which was consequently reduced to small groups of remaining stocks. Due to the new diversity of breeds it is possible to keep sheep at sites with distinct characteristics in a wide range of different biotopes. As cattle and sheep often share the same feed the latter are mainly kept on sandy and low-yield sites which are typical for Brandenburg. There is a considerable variability of distinctive differences between individual breeds. The present paper describes the specifics of the various breeds to be found in Brandenburg and assesses potentials of their employment in different grassland biotopes. This may provide a basis for further studies into genotype-environment interactions which are of practical and economic relevance for reasonable land use by sheep keeping.

Key Words: sheep, breed, grassland, location difference

Zusammenfassung
Titel der Arbeit: **Rassenspezifische Einordnungspotentiale von Schafen in unterschiedliche Grünlandbiotope**
In ein ehemaliges Kernzuchtgebiet der Merinorasse sind immer mehr Vertreter aus den nationalen und internationalen Genreservoirs eingeflossen und haben letztendlich diese bis auf Restbestände verdrängt.
Die neu geschaffene Rassenvielfalt ermöglicht den standortangepassten Einsatz des Schafes in einem breiten Biotopspektrum. Hierbei ist zu berücksichtigen, dass diese Tierart oftmals in Futterkonkurrenz zum Rind steht und deshalb schwerpunktmäßig auf für Brandenburg typischen sandigen und damit ertragsarmen Grenzertragsstandorten eingesetzt wird.
Die Variabilität der verschiedenen Merkmalskomplexe ist zwischen den Schafrassen beachtlich. An dieser Stelle wird der Versuch unternommen, rassenspezifische Besonderheiten der in Brandenburg gehaltenen Rassen darzustellen und deren Einsatzpotentiale in unterschiedlichen Grünlandbiotopen abzuschätzen. Die Ausführungen können Ansatzpunkt für die weitere Aufklärung von Genotyp-Umwelt-Interaktionen sein, die für die fachgerechte Landnutzung mit Schafen von praktischer und ökonomischen Relevanz sind.

Schlüsselwörter: Schafe, Züchtung, Grünland, Standortunterschiede

Introduction
In the federal state of Brandenburg dairy cattle and sheep are traditional grassland users. It has been only over the last ten years that more importance was attached to the keeping of suckling cows and, to a certain extent, also fallow deer.
Now the sheep farmers concentrated their efforts on the production of high-quality lamb meat and on landscape preservation.
In recent years, it has been increasingly realised that sheep keeping considerably contributes to a sustainable management of agricultural areas and to landscape preservation (ZUPP, 2003; BRÜNE and STUMPF, 2004; GROBEREK et al., 2004;

SEIBERT et al., 2004; SÜß et al., 2004). Policy-making bodies, for instance, recognised with heightened interest the favourable effects produced by sheep keeping on river dikes along the Elbe and its tributaries after the flood in 2002.
Landscape, biotope and dike preservation have developed to become major sources of income for sheep and goat farmers in Brandenburg.
Since 1991, the variety of breeds has significantly expanded in Brandenburg. Sheep were imported from all regions in Germany and from all over Europe. As a consequence, often the site-specific preservation target was not achieved, animal production performance dropped, costs increased and, in some cases, farmers gave up and sheep breeding was discontinued.
This paper, therefore, focuses on the question how the new and richer potential of breeds can be used in a more systematic way. Starting from a characterisation of the various breeds it undertakes to give an overview of the possibilities of their use in terms of the animals' living mass and fleece when kept in different grassland biotopes and under consideration of possible climatic changes.

Natural site conditions and breed structure

In old documents, Brandenburg was often referred to as the "pounce box of the Holy Roman Empire". According to agrarian statistics from the beginning of the last century, 42.5 per cent of all soil in the former administrative district of Potsdam was pure sand, the highest percentage in all provinces considered (HESSE, 1914). More recent studies show that soils with very low ground water tables with a field productivity index of under 40 are the dominant soil type here. Accordingly, 76 per cent of all agriculturally productive land belong to the EU category of "disadvantaged areas" (MINISTRY OF NUTRITION, AGRICULTURE AND FORESTRY OF THE FEDERAL STATE OF BRANDENBURG, 1993).
Brandenburg has some 280,000 hectares of grassland, so that almost 20 per cent of its agriculturally productive area is grassland. Pastures of better quality are mostly used by dairy cattle and suckling cows.
Sheep, however, are mostly herded on low-yield and "other" sites. The latter are, to a considerable extent, grassland sites with a very low productivity index, some of which were formerly used as training areas of the armed forces or extensive recultivated area after mining and are registered in cadastral maps as "not agriculturally used areas". It is intended to keep these areas open in the future. Management of the greater part of all areas used for sheep herding must comply with conditions issued by the European Union or the governmental authorities of Brandenburg on nature conservation and extensive land use. Pertinent studies show that soils in Brandenburg are frequently affected by rapid impoverishment processes (BEHLING, 2000; STRITTMATTER, 2001).
It was only after German reunification in 1991 that the consequent adaptation to the EU market caused changes of use and a growing variety of breeds.There are no continuous counts to provide exact information on the total number of animals of specific breeds. Animals registered in flockbooks of the individual breeds (these registered animals represent the highest breeding level of a population) are constantly recorded by the breeders association but the resulting figures are not very precise. The quantitative development of flockbook stocks are shown in Table 1. It must be taken into consideration that the overwhelming majority of sheep farmers work with cross-

breedings for specific uses. For cross breeding it is common to use ewes that originate from a combination of Merino Mutton sheep on the maternal line and Mutton sheep or German Whiteheaded Land sheep on the paternal line.

Table 1
Development of stocks of female breeding animals (flockbook registrations) of breeds kept in Brandenburg (Entwicklung des Bestandes an weiblichen Zuchttieren (Herdbuchtiere) der in Brandenburg gehaltenen Rassen)

Year	**1993**	**1995**	**1997**	**1999**	**2001**	**2003**	**2005**
Commercial sheep - Dual-purpose breeds							
Merino Mutton sheep	2651	2501	1864	1330	1030	292	219
Merino Land sheep	881	1259	1260	1215	1430	1542	1693
Blackheaded Mutton sheep	335	780	822	1160	1190	1062	1248
Suffolk sheep	116	170	286	20	8	5	36
Leine sheep	78	101	110	110	128	158	113
Whiteheaded Mutton sheep	60	70	105	50	40	35	25
Texel sheep	6	120	159	145	150	155	145
Romney Marsh sheep	-	80	100	-	-	-	-
Hampshire sheep	-	10	16	20	22	22	22
Triple-purpose							
East Friesland Milk sheep	383	259	269	273	258	229	174
Land race sheep							
Skudden sheep	285	201	217	255	520	659	901
White Hornless Heath sheep	140	330	168	30	134	124	102
Rough-Haired Pomeranian Land sheep	120	110	109	165	161	222	226
Rhon sheep	30	35	35	10	-	43	49
Grey Horned Heath sheep	-	90	212	260	395	447	201
Hungarian Prong Horn sheep	-	50	51	56	66	61	65
White Horned Heath sheep	-	30	30	40	-	-	-
Camaroon sheep	-	10	36	65	2	11	11
Bentheim Land sheep	-	-	160	340	313	408	281
Gotland Furred sheep	-	-	130	85	112	158	131
Ouessant sheep	-	-	3	5	7	7	13
Soay sheep	-	-	-	34	12	12	8
Coburg Fox sheep	-	-	-	13	18	48	71
Gotland sheep	-	-	-	6	11	11	6
Romanov sheep	-	-	-	-	-	5	-
Dorper sheep	-	-	-	-	-	4	4

Stocks of Merino Mutton sheep have undergone dramatic changes over the last 13 years (STRITTMATTER, 2004; FISCHER, 2004). Within this short period, the breed lost its once dominating role despite the fact that efforts to switch breeding from wool producing to meat producing breeds started immediately after 1990. At present, there are only two flockbook-registered flocks where breeding of these animals is continued. Supportive measures should be taken to protect the last remaining stocks. On the other hand, stocks of more productive and more profitable German Whiteheaded Land sheep and Blackheaded Mutton sheep have increased. Initially, Suffolk sheep, an

internationally relevant mutton sheep breed, showed a promising development. In differing environmental conditions this breed proved its high genetic potential in terms of fattening and meat producing performance. However, stocks dropped abruptly caused by scrapy. Breeding of Romney Marsh (Kent) sheep, another world-wide known breed, was discontinued after a only a few years. A small number of breeders keep some other intensive breeds. Due to high management demands and small flocks their use in maintenance programmes is limited. East Friesland milk sheep, a relatively fastidious breed which produces milk, meat, and wool, is mainly herded for milk production.
The cheese made from the milk is predominantly marketed in and around Berlin.
Extensive breeds are often kept by people without agricultural training or education. The number of Skudde sheep, the physically smallest breed in Germany and threatened with extinction, has considerably grown in recent years thanks to combined development programmes financed by the EU and the state of Brandenburg. It causes no problems to keep this quite undemanding land sheep breed, which produces a small and palatable carcass, on the dry sites in Brandenburg.
As a result of continuous development of stocks, it is this breed and notably mHaired Pomeranian Land sheep, Leine sheep, Grey Horned Heath sheep, and Bentheim Land sheep that are of relevance for the management of specific biotopes.
Apart from performance characteristics and ethological specifics, the origin of the populations concerned, i.e. natural site conditions at their places of origin including such factors as climate, soil characteristics, and fodder as well as the development of certain external characteristics, can be of decisive significance for the assessment of ecological performance potentials. Table 2 gives an overview of the partly very differentiated original conditions of breeds to be found in Brandenburg. It is to be noted that now breeds of all fleece types from merino sheep to hair sheep are kept in Brandenburg (Sources: HAMMOND et al., 1961; MEYNEN et al., 1962; THULKE, 1981; HARING, 1984; VDL, 1999; FISCHER, 2003).

Table 2
Origin and site conditions at the place of origin of breeds kept in Brandenburg with regard to fleece type and breed group (Herkunft und Haltungsbedingungen der Zuchtheimat der in Brandenburg gehaltenen Rassevertreter unter Berücksichtigung von Vliestyp und Rassengruppe)

Breed	Place of origin	Natural conditions at original site
1. Merino sheep		
Merino Mutton sheep	Germany Saxony, Brandenburg, Saxony-Anhalt, Lower Saxony	arable cropping sites with dry continental climate
German Whiteheaded Land sheep	Germany Bavaria, Baden-Württemberg	half-dry grassland and higher yield pastures
2. Long-woolled mutton breeds		
2.1. English long-woolled mutton breeds		
Romney Marsh	Britain Romney-Moore, south-east England	marshland and low-lying forage grassland; high-rainfall sites
2.2. Sleek-haired marshland breeds		
GermanWhiteheaded Mutton sheep	Germany Friesland, Oldenburg, Schleswig-Holstein	marshland pastures, saline foreshore meadows, dikes; maritime climate (relatively high atmospheric humidity, high precipitation)
Texel	The Netherlands Island of Texel in the North Sea	intensively managed grassland, maritime climate
East Friesland Milk sheep	Germany North Sea coastal area	marsh pastures, sandy ground moraine; maritime climate

Table 2 (continuation)

Bentheim Land sheep (marsh sheep x heath sheep)	Germany Emsland region	organic wetland, heath and bogs with heath formation, littoral climate
3. Short-woolled mutton breeds and descents from breed combinations		
Hampshire sheep	Britain Hampshire, south-west England	thoroughly moistened, forage grassland (lime soil)
Suffolk sheep	Britain Suffolk, south-east England	high-yield arable and grassland areas
Blackheaded Mutton sheep	Germany Westphalia, Schleswig-Holstein	high-yield forage sites, maritime climate
4. Straight-haired land sheep		
Rhon sheep	Germany, Rhon (central German low mountain range)	low-yield soils (upland heath, bogs, forest pastures) wet and cool low-mountain sites
Coburg Fox sheep	Germany, Norzthern Bavaria	rough and wet low-mountain sites
Leine sheep	Germany, southern Lower Saxony	better soils (*i.a.* loess and loess clay) sites with high precipitation
5. Coarse-wool breeds *5.1. Mixed-woolled land sheep*		
Rough-Haired Pomeranian Land sheep	Germany, Pommerania incl. Islands of Rügen, Usedom and Hiddensee	rolling ground morains, low-yield sandy soils and fens or wet pastures, relatively high moisture
5.2. North-European heath sheep		
Skudde sheep	The Baltic, south-eastern Baltic region	light soils with poor vegetation, fens, heath and dry grassland, rough climate
Grey-Horned Heath sheep	Germany, Lüneburg Heath	dry, low-nutrient heath sites, sandy and gravelly soils, relatively high precipitation
White-Horned Heath sheep	Germany, Weser and Ems region	wet fens and dry heath sites
White Hornless Heath sheep	Germany, western edge of Lüneburg Heath	wet biotopes and low-yield dry heath
Gotland Fur sheep	Sweden	temperate summers, hard withers with high snow falls
Gotland sheep	Sweden, Island of Gotland	low-yield dune heath sites
Soay sheep	Britain, Isle of Soay off north-west Scotland	low feed availibility, rough climate
Ouessant sheep	France, Island of Ouessant off western Brittany	low feed availibility, rough climate
5.3. South-east European and east-European coarse-woolled breeds		
Prong Horn sheep	Hungary	contionental climate, severe draughts in years with no summer rains
Romanow	Russia, various regions, *e.g.* Volga region	low-yield sites with feed featuring high fibre content, high variations in temperatures, cold winters
6. Hair sheep		
Camaroon sheep	western Africa	equatorial region with Atlantic and continental climate
Dorper	southern Africa	rather dry and poor vegetation, continental climate

Most commercial breeds originate from regions with high-yield grassland areas and higher precipitation. The north European short-tailed heath sheep mostly come from various low-yield regions with a rather rough and capricious climate. Regions with continental climate are the original habitat of Merino Mutton sheep, Romanov sheep , Hungarian Prong Horn sheep, and hair sheep.

The capacity to adapt to new environmental conditions apparently varies from breed to breed. Some breeds are capable to cope with a very wide range of conditions, while this range may be rather limited for others. Relevant results and reports are predominantly based on practical experience. Systematic animal ecology studies on relevant genotype-environment interactions are rather rare.

Biotope-related plant yields

The soil types of grassland areas in Brandenburg are 27.5 per cent sand, 7.5 per cent clay, 10.8 per cent half-bog, and 54.2 per cent bog (MINISTRY OF NUTRITION, AGRICULTURE AND FORESTRY, 1994). The feed quality of grassland crops is largely dependent on plant stand populations and management intensity. Decisive factors in this context are the time and frequency of land use.

Table 3 is based on uniform dates for different sites in Brandenburg that are particularly suitable for sheep keeping in this region.

Table 3
Influence of different sites and plant communities on yield and nutrient concentration under extensive grassland management (Einfluss unterschiedlicher Standorte und Pflanzengesellschaften auf Erträge und Nährstoffkonzentrationen bei extensiver Grünlandbewirtschaftung)

Site	Growth	Date	Tussok grass, river-side meadow/pasture		Poa-quack grass grassland	
			DM (dt/ha)	EC (MJ ME·kg^{-1} DM)	DM (dt/ha)	EC (MJ ME·kg^{-1} DM)
Sand with far						
groundwate table	1st	5/30			9.2	9.8
(Moisture 4-)	2nd	7/20			6.6	8.3
(Nutrient A)	3rd	9/30			7.7	8.7
Flood plains.						
Pleistocene	1st	5/30	18.6	10.0	22.2	10.2
clay and loam	2nd	7/20	21.8	8.8	26.1	9.0
soils	3rd	9/30	23.8	8.8	28.3	9.8
(Moisture 2-)						
(Nutrient B)						
Low moors						
(Moisture 3+)	1st	5/30	11.5	9.8	13.1	10.3
(Nutrient A)	2nd	7/20	13.5	8.7	15.3	9.0
	3rd	9/30	14.8	8.7	16.7	9.2

Site	Growth	Date	Creeping red fescue- poa grassland		Cockkfoot-poa- grassland	
			DM (dt/ha)	EC (MJ ME·kg^{-1} DM)	DM (dt/ha)	EC (MJ ME·kg^{-1} DM)
Sand with far						
groundwate table	1st	5/30	6.4	9.5	9.6	8.8
(Moisture 4-)	2nd	7/20	4.6	8.0	6.9	9.3
(Nutrient A)	3rd	9/30	5.4	8.3	8.1	9.2
Flood plains.						
Pleistocene	1st	5/30	11.6	10.2	23.4	9.0
clay and loam	2nd	7/20	13.6	8.8	27.4	9.7
soils	3rd	9/30	14.8	9.0	29.9	9.8
(Moisture 2-)						
(Nutrient B)						
Low moors						
(Moisture 3+)	1st	5/30	6.7	10.2	12.9	9.5
(Nutrient A)	2nd	7/20	7.8	9.0	15.2	9.7
	3rd	9/30	8.5	9.0	6.6	9.3

The yield and quality data were supplied from data banks based on results achieved both in experiments and agricultural practice. The values for metabolisable energy (MJ ME·kg DM^{-1}) are based on raw nutrient contents derived from feed analyses and estimation equations (WEISSBACH, 1999).
Peak values of metabolisable energy are around 7.8 and 10.3 MJ ME·kg DM^{-1}. Yields are lowest on sandy sites with low ground water tables. On sites with such conditions, regrowth takes longer with decreasing feed values. Yields are markedly higher on other sites but they are largely dependent on vegetation forms. The metabolisable energy values in Table 3 are probably still too high as the actual energy contents of grassland crops are distinctly lower than the given values from estimation equations as has been proved by *in vivo* digestibility trials (HERTWIG and BAECK, 2002; HASSELMANN and FISCHER, 2003; GROBEREK et al., 2004). On the other hand, large-range selective pasturing allows sheep to take up better feed than the stand’s average while low-quality herbage remains there as pasture grass leavings (BRÜNE and STUMPF, 2004).

Breed-specific basics for site-related classification of sheep
There are certain specifics to every breed. They manifest themselves in the living mass, which is closely related to nutritional requirements and thermal balance, in fleece characteristics, digestive physiology, and ethological qualities.
Performance and health decisively depend on the satisfaction of daily dry matter and nutrient requirements. These requirements are, *inter alia*, related to the living mass of the animal concerned. According to JEROCH et al. (1999), the intake of dry matter of non-pregnant and in-lamb ewes varies between 1.0 kg and 2.3 kg per animal and day. It increases by 0.5 kg in the lactation period. DREPPER and ROHR (1984) reported dry-matter intakes of 2.5 kg to 2.8 kg per 100 kg of sheep. As this source is related to the living mass it is used as a basis on which the intake of dry matter is estimated.
JEROCH et al. (1999) stated weight-related energy and crude protein requirements which are based on data of the Ausschuss für Bedarfsnormen der Gesellschaft für Ernährungsphysiologie GfE (1996) and the Rostock feed evaluation system (2003). According to them, 430 kJ of metabolisable energy and 4.7 g of crude protein are required for the maintenance (including mean wool yield and locomotive activities) of 1 kg of metabolic living mass ($W^{0.75}$) per day. During pregnancy and lactation the maintenance requirement increases by about 30 per cent to 40 per cent, dependent on single or twin births.
Table 4 shows the requirement values of dry matter, energy and crude protein that result from the above equations with estimations being based on the mean living masses of ewes according to the applicable breeding standards. It demonstrates the high degree of variability in the daily requirements of different breeds and indicates both limits and possibilities of their site-related employment.
Seasonal nutrient requirements are largely influenced by reproductive activities. Figure illustrates the daily nutrient requirement of a ewe in an annual cycle. Between winter and spring, the nutrient requirement increases in the last phase of pregnancy and during the four-month nursing period. If high costs of winter feed are to be avoided, conserved feed (notably hay) must meet appropriate standards in terms of quality and quantity. Except a relatively short flushing period to stimulate the intensity of oestrous activities, it is sufficient to meet the maintenance requirement according to living

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mass. In natural reproduction conditions, this period is in the second half of the vegetation period, which is marked by an increase of the crude fibre contents of older green forage.

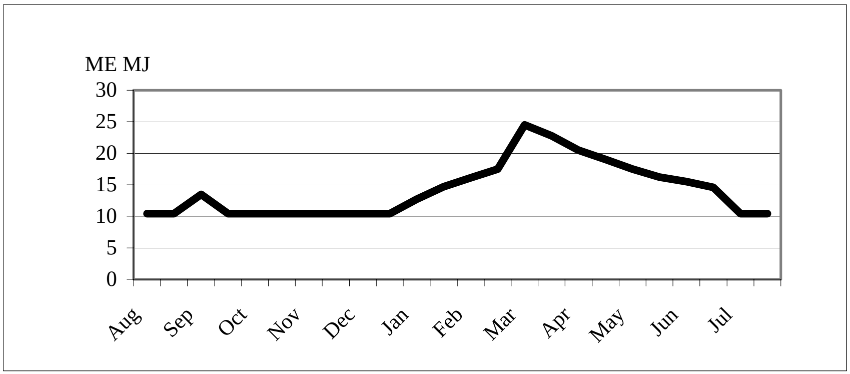

Figure: Energy requirement of ewes related to reproductive stage (70 kg living mass, twins) (mod. after JEROCH et al., 1999) (Energiebedarf von Mutterschafen in Abhängigkeit vom Reproduktionsstadium (70 kg LM, Zwillinge) (mod. nach JEROCH et al., 1999))

Table 4
Estimated dry matter and nutrient requirements of sheep kept in Brandenburg (per ewe and day) (Schätzung des Trockensubstanz- und Nährstoffbedarfs der in Brandenburg gehaltenen Rassen (pro Mutterschaf und Tag))

Breed	Living mass	Metabolic living mass	Dry matter intake	Energy maint. requirement	Crude protein requirement
	kg	kg $^{0.75}$	kg·d^{-1}	MJ ME·d^{-1}	g CP·d^{-1}
Suffolk	95	30.4	2.5	13.1	143.0
Blackheaded Mutton	85	28.0	2.3	12.0	131.6
Whiteheaded Mutton	85	28.0	2.3	12.0	131.6
East Friesland Milk	85	28.0	2.3	12.0	131.6
Merino Land	80	26.7	2.1	11.5	125.7
Hampshire	80	26.7	2.1	11.5	125.7
Dorper	78	26.2	2.1	11.3	123.4
Merino Mutton	78	26.2	2.1	11.3	123.4
Leine	78	26.2	2.1	11.3	123.4
Texel	75	25.5	2.0	11.0	119.8
Romney Marsh	65	22.9	1.7	9.8	107.6
Bentheim Land	65	22.9	1.7	9.8	107.6
Coburg Fox	65	22.9	1.7	9.8	107.6
Romanow	65	22.9	1.7	9.8	107.6
Rhon	60	21.6	1.6	9.3	101.3
Gotland	53	19.6	1.4	8.4	92.3
Rough-Haired Pomeranian Land	53	19.5	1.4	8.4	91.7
Gotland Fur	50	18.8	1.3	8.1	88.4
Grey-Horned Heath	45	17.4	1.2	7.5	81.7
White-Horned Heath	43	16.8	1.1	7.2	78.9
Prong Horn	43	16.8	1.1	7.2	78.9
White Hornless Heath	43	16.6	1.1	7.2	78.2
Skudde	35	14.4	0.9	6.2	67.6
Camaroon	35	14.4	0.9	6.2	67.6
Soay	25	11.2	0.7	4.8	52.5
Ouessant	15	7.6	0.4	3.3	35.8

As a consequence, digestibility of organic mass decreases. Digestibility depressions cause a marked reduction of resorbed digestible nutrients. Feed intake is further reduced by the increasing lignification of crude fibre fractionation. The dry matter intake of sheep in relation to living mass and feed fibre contents is calculated in Table 5.

Table 5
Dry matter intake (T) of sheep used for landscape conservation related to living mass and crude fibre content (XF) of herbage (Trockensubstanzaufnahme (T) von Schafen in der Landschaftspflege in Abhängigkeit von der Lebendmasse und dem Rohfasergehalt (XF) des Weidefutters)

g XF / kg T	250	300	350
Apparent digestibility of organic substance (per cent)	71	62	54
Living mass (kg)			
90	2.43	1.58	1.11
60	1.62	1.05	0.74
30	0.81	0.53	0.37

With an estimated possible dry matter intake on marginal sites of 8.5 to 9.0 MJ ME/DM the maintenance requirement can hardly be met. Furthermore, it is to be expected that feed intake is reduced by another 10 per cent during high summer dryness. At higher temperatures (>28 ^{0}C), the thermo-static regulation of feed intake is a limiting factor. It is on the basis of these factors that different sheep breeds may be categorised according to their feed intake abilities in conditions of extensive grassland management. Table 6 demonstrates a respective categorisation of sheep breeds in Brandenburg. It is to be stressed that the estimation result has to be further supported by scientific studies on the relation between feed intake ability and living mass and breed.

Table 6
Categorisation of breeds related to potential feed intake capacity in conditions of extensive grassland management (Rassenzuordnung entsprechend deren potentiellen Futteraufnahmevermögens im Rahmen der extensiven Grünlandbewirtschaftung)

Feed intake capacity		
good	average	insufficient
Leine sheep	Hampshire sheep	Suffolk sheep
White Hornless Heath sheep	Dorper sheep	Blackheaded Mutton sheep
Grey Horned Heath sheep	Merino Mutton sheep	Whiteheaded Mutton sheep
Prong Horn sheep	Texel sheep	East Friesland Milk sheep
White Horned Heath sheep	Romney Marsh sheep	Merino Land sheep
Skudde sheep	Bentheim Land sheep	Ouessant sheep
	Coburg Fox sheep	Soay sheep
	Romanov sheep	
	Rhon sheep	
	Gotland sheep	
	Rough-Haired Pomeranian Land sheep	
	Gotland Fur sheep	
	Camaroon sheep	

Due to their high dry matter and nutrient requirements the employment of heavy commercial breeds for purposes of landscape preservation is possible, though limited. They must be offered additional traditionally managed areas in order to limit more cost-intensive supplementary forage.

The ability of some breeds (*e.g.* German Heath sheep, Bentheim Country sheep) to take in large quantities of feed with high crude fibre contents (FÖRSTER and KNEIS, 1999) and to increase their rumen volume can be of practical relevance for landscape preservation. As a result, the feed stays longer in the rumen and the digestibility of organic matter increases. This adaptibility is not found with high performance breeds characterised by high growth intensity (JEROCH et al., 1999).
The anticipated climatic change necessitates a different assessment of living mass and fleece structure in the future. There is a direct relationship between feed intake, energy metabolism, performance, and thermal balance. Body and surface are related in inverse proportion. Therefore, small-sized breeds feature a relatively larger exothermal surface than big-sized breeds (Bergmann's rule of size) which means that small animals show a higher heat tolerance. In addition, sheep without or with more coarse mixed-woolled or straight-hair fleece have a higher heat tolerance since such fleeces keep less stagnant air between wool fibres and hair. In a simplified way one may say that, due to the prognosticated climatic changes, more importance will attach to small-framed ewes in the future. Keeping lighter breeds with lower maintenance requirements may be an answer to a temperature-related decrease of grassland plant yields. It would be recommendable, in this connection, to focus breeding efforts on the development of skin pigmentation or coloured and flecked wool. This, however, is at variance with the requirements of the textile industry where white wool is wanted, which is supported by pricing measures. On the other hand, it is known from experience that pure white and unpigmented sheep may suffer from sunburn with negative effects on health and performance when exposed to high solar UV-B radiation (GESCHKE, 1999). Besides, there is also a wide range of possibilities to process coloured wool as a re-growing raw material.
The mating of rams of large-framed and meat-type breeds with small-framed ewes may improve the position on the lamb meat market. Such a development would, however, get along with lower store lamb proceeds per ewe due to reduced performance in terms of fertility performance and fattening and carcass yield, which will not be possible to be completely compensated for (BAEHNE and BEHLING, 1998). In the final analysis, this underlines the importance of overall conditions to be ensured by agricultural policy measures which must take into consideration both market performance and a monetary evaluation of landscape conservation effects of sheep farming in order to guarantee at least an adequate compensation for income losses.

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