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Fertility of sheep and goats in Slovenia

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ABSTRACT

Trait and parameter definitions for the evaluation of fertility in sheep and goats in Slovenia are discussed. Fertility results for sheep and goats in controlled Slovenian herds for the period 1995-1999 are presented. The average litter size in 1998 was 1.45 (born)/1.36 (live) in sheep, and 1.73 (born)/1.67 (live) in goats. The number of lambs born per ewe per year was 1.97 in sheep and 1.7 in goats.
(Keywords: sheep, goats, fertility, lamb production, performance recording)

ZUSAMMENFASSUNG

Fruchtbarkeit von Schafen und Ziegen in Slowenien
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In vorliegender Arbeit werden die Fruchtbarkeitsparameter von Schafen und Ziegen diskutiert. Dargestellt werden die Fruchtbarkeitsleistungen in den kontrollierten Herden in den Jahren 1995 bis 1999. 1998 betrug bei Schafen die durchschnittliche geborene Lämmerzahl 1,45/1,36 lebenden, und bei Ziegen durchschnittlich 1,73 geborene/1,67 lebenden Ziegenlämmern. Die Zahl der geborenen Lämmer pro Jahr betrug 1,97, der Ziegenlämmer jährlich 1,7.
(Schlüsselwörter: Schafe, Ziegen, Fruchtbarkeit, Leistungsprüfung)

INTRODUCTION

Performance recording for sheep and goats in the Slovenian small ruminant breeding programme was initiated in 1989. The information system is gradually being built and upgraded (*Drobnic et al., 1995*). After the basic production module and the milk recording module (*Kompan et al.,* 1997), the module for the evaluation of reproductive efficiency is under development.

The two most numerous sheep breeds in use in Slovenia are the Jezersko-Solcava and the Improved Jezersko-Solcava Sheep breeds (JS and JSR), which are meat breeds fertile throughout the year and suitable for the frequent lambing management system. The Bovec Sheep and Improved Bovec Sheep breeds (B and VFB) are dairy breeds and are seasonally fertile. The goats are used predominantly for milk production.

Fertility is evaluated at two levels: level one is to assess the productivity of an individual flock, and level two is to assess the productivity of an individual female. This article focusses on evaluating the reproductive efficiency of flocks: specifically, lamb production, based on regularly collected data.

DEFINITION OF FERTILITY TRAITS

Exact definition of fertility traits and evaluation parameters is a premise and a basic requirement for ongoing monitoring of fertility within a breeding programme. Fertility traits and reproductive efficiency evaluation parameters have been described by many authors and can be found in most sheep production textbooks. However, in practice it is often the case that certain data are not available or not always available. In such cases the formulas are 'stretched', and trait and parameter definitions are no longer clear.

In Slovenia sheep and goats are produced predominantly under extensive conditions. As a consequence, it is not always straightforward to define how to define certain production evaluation parameters. That is, 'extensive conditions' implies that the data collected are frequently of limited quality in terms of availability and accuracy. In general, some data elements are generally more dependable than others. Consequently, parameters that are based on these data are also more reliable. When interpreting results, it needs to be clear how reliable a certain parameter is.

Often, when data are missing, 'calculated' surrogate values are used. Depending on the proportion of measured against 'guessed' values, the reliability of a parameter value varies. Sometimes some breeders provide most of the data, while others will be almost entirely estimated. There is poor comparison between the parameters for two such breeders. Likewise, comparing a certain breeder against the national average may be questionable. Furthermore, some data are easier to collect accurately than others, and may generally be more worthy of trust.

Of course, breeders must at all times be encouraged to provide high quality data. Well designed practices, an understanding of the impact of accurate data on the information produced, regular revision and control of data collecting practice, animal identification, and the benefit of regular access to their own results and results for flocks raised in similar conditions will motivate breeders to recognise the benefit of high quality data records. However, reproductive efficiency evaluation parameters within a breeding programme are expected to measure reproductive efficiency in a way that can be used within the national breeding programme, taking into account the existent conditions: flocks of various sizes, different breeds, both meat and dairy, and different management technologies, and different levels of production intensity.

Lamb production efficiency evaluation parameters

The basic requirements for any parameter set to describe sheep fertility, specifically lamb production, are: firstly, to provide evaluation of the productivity of animals, to evaluate overall productivity, and to give an insight into factors affecting the results achieved; secondly, to ensure a reasonable level of reliability throughout the breeding programme population, the parameters must be based on records of a certain minimal level of quality; thirdly, to ensure comparability among flocks; lastly, to ensure comparability with other populations, mainly by providing clear definitions of the parameters in use.

The parameters of productivity describe the output of the production unit - the flock. From the perspective of lamb production, the output is the total weight of lamb at the time of sale. More specifically, the lamb output is: the total weight (or number) of male lambs selected for breeding stock or test * breeding value factor + the total weight (or number) of female lambs selected for breeding stock * breeding value factor + the total weight of slaughter lambs * carcass classification value. Evaluation of this

parameter assumes that the three 'values' are known - but they are not fixed. The parameters discussed can be summarised as follows.

Summary of parameters describing fertility of females in sheep (and, accordingly, goats)

Productivity in a defined time period ('year')	
a) Total lamb output	unkn. comp.
b) Total lamb weight at time of sale	unstandardised
c) Total lamb weight at standardised age	unstandardised
d) Lamb weight per female per year	reliability
e) Number of lambs reared per female per year	reliability
f) Number of lambs born per female per year	reliability
g) Number of lambs born alive per female per year	reliability
h) Lamb weight per fertile female per year	+
i) Number of lambs reared per fertile female per year	+
j) Number of lambs born per fertile female per year	+
k) Number of lambs born alive per fertile female per year	+
l) Number of litters per year per female / fertile female (in the observed year)	+
m) Period between parities per female / fertile female (in the observed year)	+
n) Age at first lambing	+
o) Period between flock entry and first lambing	+
Litter size traits:	
p) Number of lambs born per litter	+
q) Number of lambs born alive per litter	+
r) Number and percentage of stillborn lambs	+
s) Number of lambs reared per litter	+
t) Losses: number and percentage of lambs lost in rearing	+

The parameter 'total lamb weight at time of sale' works for a particular keeper, but lacks comparability for general use within the breeding programme. It needs to be corrected to a uniform age at weighing. Keepers sell lambs at very different ages. There are two possible solutions: either correcting the weight to a 'standard' age (e.g., with linear interpolation), or asking the keepers to weigh lambs at a certain approximate age (or weight). The first, due to large variation of sale age, is highly inaccurate, while the second is impractical for the keeper.

The parameter 'total lamb weight at standardised age' still needs to be normalised to a female, to exclude the flock size effect, and to a time period. The time period is usually a year, and due to seasonal productivity of the large proportion of the population, the time period is usually taken to be November - October, referred to as the 'year'. The number of females in the flock is the average flock size (females only) throughout the year, or the total number of days spent on stock divided by 365:

sum (each female (31 October *or* culling date, whichever is sooner *minus* 1 Nov. following yr *or* flock entry date, whichever is later)) *divided by* 365.

The parameter 'lamb weight per female per year' (d), and also e, f and g, are highly informative parameters, recommended as good measures of lamb crop (e.g., *Brown et al, 1989, Wickham et al, 1982*) and also used as a measure of productivity in pigs (*Kovac et al., 1992*). Unfortunately, it is based on records that are at present of low reliability in the Slovenian sheep and goat breeding programme, and thus the parameter is unreliable. Culling date, needed to calculate the average flock size, is one of the data records not collected with sufficient reliability. Flock entry date, on the other hand, is sufficiently reliable because breeding stock replacement has been associated with breeding stock premiums (although the breeding stock replacement premium scheme has been discontinued in 1999). Where replacement females are selected from the breeder's own flock there arises the problem of defining when 'a ewe becomes a ewe'; that is, from what age on she is considered to be part of breeding stock and a debit to the breeding stock account. Despite the fact that the parameters d, e, f and g cannot at present be evaluated with sufficient reliability, this highly informative value calls for efforts to overcome the problems in the near future, either by improving the present data collecting mechanisms, or by introducing auxiliary ones.

Table 1

Sheep fertility results in controlled flocks in Slovenia in 1998

Breed (1)	No. of flocks (2)	No. of litters (3)	No. first litters (4)	Age at lambing (yrs) (5)	Parity (6)	Age at first lambing (7)	Period between parities (8)	Lambings per fertile ewe per year (9)	Litter size (born) (10)	Litter size (live) (11)	Lambs born per fertile ewe per year (12)
Total (13)	**192**	**6262**	**1230**	**3.46**	**3.69**	**477**	**268**	**1.36**	**1.45**	**1.36**	**1.97**
Jezersko-Solcava	71	1920	299	3.82	4.18	488	261	1.40	1.27	1.21	1.78
Improved JS	75	3005	596	3.13	3.58	443	238	1.53	1.60	1.48	2.45
Texel	2	37	5	4.15	3.46	728	383	0.95	1.65	1.49	1.57
B. Krajina Z.	13	126	19	5.20	4.63	556	238	1.53	1.13	1.09	1.73
Bovec	19	698	177	3.45	3.11	492	351	1.04	1.36	1.33	1.41
Improved B	7	156	33	3.55	3.26	428	362	1.01	1.58	1.47	1.60
Istrian Z.	5	276	100	3.27	2.51	607	370	0.99	1.31	1.28	1.30

1. Tabelle: Fruchtbarkeitsergebnisse bei Schafen in den kontrollierten Herden Sloweniens im Jahre 1998

Genotyp(1), Anzahl der Herden(2), Geborene Lämmer gesamt, Stück(3), Gesamtzahl der Lämmer bei 1. Ablammung(4), Durchschnittl. Ablammungsalter pro Mutterschaf, Jahre(5), Parität(6), Alter der Mutterschafe bei 1. Ablammung, Tage(7), Zeitraum zwischen den Paritäten, Tage(8), Zahl der Ablammungen pro Mutterschaf/Jahr(9), Anzahl der geborenen Lämmer pro Geburt(10), Anzahl der lebenden Lämmer/Geburt(11), Lämmerzahl pro Mutterschaf/Jahr(12), Gesamt(13)

An alternative to d, e, f and g which is less informative but more reliable is to base the parameter on females which have lambed: number of lambs per fertile female per year (h, i, j and k). This parameter excludes information on unproductive ewes. However, it is

based on sufficiently reliable records and provides good means for between-flock and year-to-year comparison of results.

The parameters l to t are simple, analytical parameters which assist in the explanation of the composite parameters. They are based on reliable records and provide solid ground for analysing factors that affect lamb production in sheep and goats.

FERTILITY OF SHEEP IN SLOVENIA

Data for controlled flocks from 1995 to April 1999, with special focus on the year 1998, have been analysed in accordance with the parameter definitions described. Fertility is evaluated in herds with over 20 dairy or over 30 meat animals. Fertility is also observed in all herds included in the gene preservation programme. In the period 1995 to April 1999 26,700 lambings were recorded, and in 1998 4972 ewes in controlled herds produced 6262 litters. In 1998 *(Table 2*) 25% were first lambings and 75 % repeated lambings. The mean age at lambing was 3.46 years, varying from 3.13 (Jezersko-Solcava) to 5.20 (Bela Krajina Zackel). The latter breed was included in the breeding programme in 1997 and the results are less reliable. The average parity of ewes at lambing was 3.7, 2.5 in Istrian Zackel and 4.6 in the Belo Krajina Zackel Sheep breed. The age at first lambing varied, and was generally lower in the breeds with all-year breeding, and higher in the breeds with seasonal breeding. The total average was 477 days.

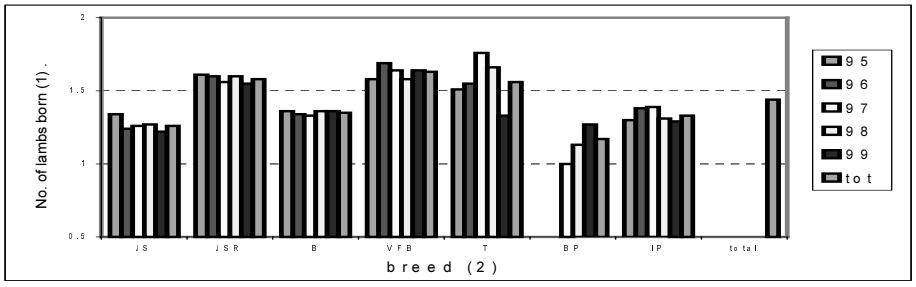
Litter size

Parameters used to evaluate litter size are number of lambs born per litter, number of lambs born alive, and, derived from the two, number and proportion of lambs lost.

The average litter size for 1998 was 1.45 lambs born and 1.36 born alive. These values are slightly higher than the results for the last five years (1.44 and 1.35 respectively). It is possible to notice a slight trend of increasing litter size throughout the last five years. The percentage of stillborn lambs remained constant during this period, at 3.2 %, this being the same as in 1998.

Fig. 1

Litter size (number of lambs born) in Slovenian sheep breeds over the years



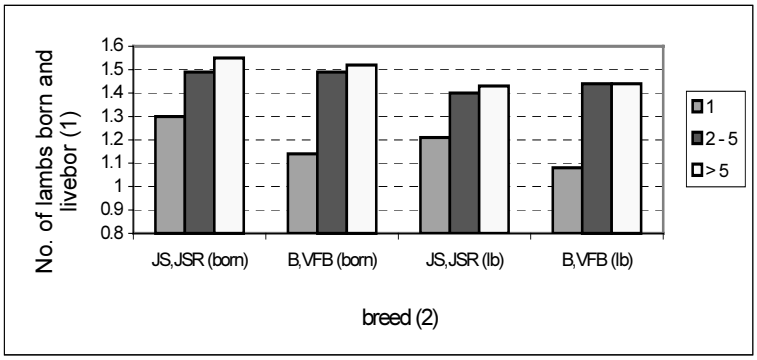
1. Abbildung: Anzahl der geborenen Lämmer bei den slowenischen Schafrassen in den Jahren 1995 bis 1999

Anzahl der geborenen Lämmer(1), Genotyp(2)

The differences in litter size among breeds which had been expected were observed (*Fig. 1*). The highest litter size was attained among the crossbreeds ('improved breeds'). Litter size is generally higher in larger flocks, as is the number of lambs born alive, and the rate of losses is lower. This trend is observed in both meat and dairy sheep breeds. As expected, litter size increases with parity in the ewes.

Fig. 2

Litter size (lambs born alive) in the Jezersko-Solcava and Improved Jezersko-Solcava (JS, JSR) and Bovec and Improved Bovec (B, VFB) breeds from 1995 to April 1999



2. Abbildung: Anzahl der lebend geborenen Lämmer der Genotypen Jezersko-Solcava und Veredelte Jezersko-Solcava (JS, JSR) und Bovec und Veredelte Bovec (B, VFB) in den Jahren 1995 bis 1999

Anzahl der lebend geborenen Lämmer(1), Genotyp(2)

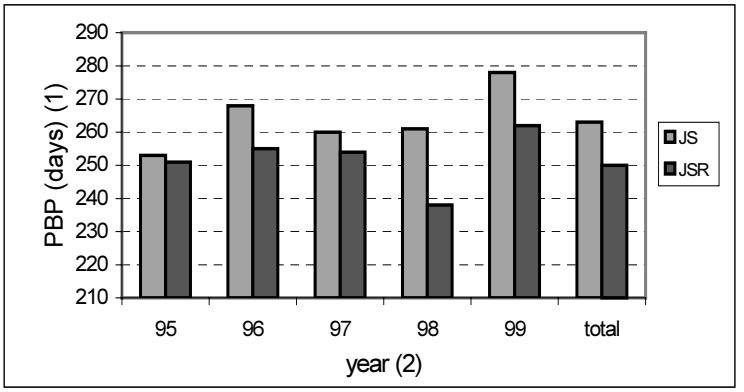
Period between parities and number of lambings per ewe per year

Period between parities is an important measure of fertility in flocks where year-round breeding is practised. All dairy sheep breeds, and also some meat breeds, are seasonally fertile, and this can only be changed by means of treatment of an 'artificial' nature. In these breeds the period between parities is invariably close to 365 days, and the parameter is hence somewhat less informative. A more prolonged period merely reflects absence of lambing in individual ewes.

In meat breeds, specifically in flocks in which continuous, year-round breeding takes place, the period between parities (PBP) is one of the most important indicators of productivity. In these breeds PBP is affected by technology (i.e., service and weaning), and other, mainly environmental effects. Therefore, managerial decisions will contribute to attempts to attain optimal PBP. The average gestation period in sheep is 150 days, and this sets theoretical limits to PBP. The average PBP recorded in 1998 in controlled Slovenian flocks is 246 days for meat breeds.

Fig. 3

Period between parities in the Jezersko-Solcava (JS) and Improved Jezersko-Solcava Sheep (JSR) breeds from 1995 to April 1999



3. Abbildung: Zeitraum zwischen den Paritäten beim Genotyp Jezersko-Solcava (JS) und Veredelte Jezersko-Solcava (JSR) in den Jahren 1995 bis April 1999

Zeitraum zwischen den Paritäten (PBP) Tage(1), Jahr(2)

Fig. 3 shows PBP for the Jezersko-Solcava and the Improved Jezersko-Solcava breeds in 1998. Slightly lower PBP was recorded in the Improved Jezersko-Solcava (238 days in 1998, 250 in the last five years), and in the pure breed Jezersko-Solcava (261 days in 1998 and 263 in the last five years). There was no substantial change of the period between parities with increasing age in these ewes, nor was substantial change observed with growing flock size, PBP perhaps being slightly longer in larger flocks.

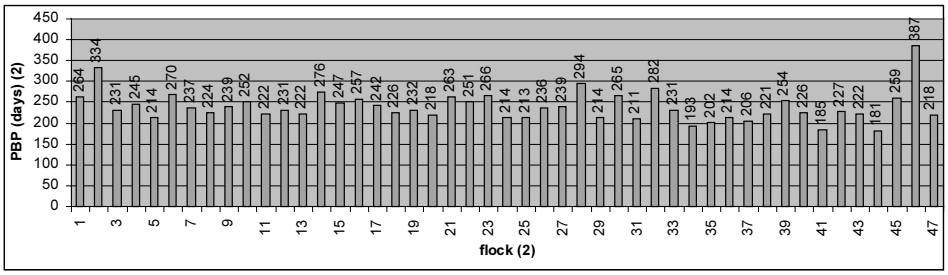
Fig. 4 shows PBP for 1998 across flocks of the Improved Jezersko-Solcava breed. It is evident that flock PBP is highly variable. PBP values for some flocks deviate even up to a duration of one year or longer. These are breeders with small herds who reduce labour input by seasonal breeding and thus concentrate lambings into a short period. Flocks with a short PBP typically have lambings distributed almost evenly throughout the year, although there is a slight recess in the summer months. Evidently, some breeders are striving to intensify production, while part others practise extensive breeding.

The Belokranjska Pramenka breed was recognised as an autochthonous breed for the gene conservation programme, and was introduced into the Slovenian breeding programme in 1997. The number of animals of this breed in controlled flocks is thus still relatively low; 121 lambings in 13 flocks were recorded in 1998.

The number of lambings per ewe per year is derived from the period between parities as an inverse value (365/PBP). As such, this value has the same informative message as the PBP, but it illuminates the situation from a different perspective. In 1998 the average Jezersko-Solcava ewe produced 1.4 litters per year, and the Improved Jezersko-Solcava 1.53. The values are slightly increased compared to the five-year averages (1.39 and 1.46 litters per ewe per year). The average for all sheep in the breeding programme in 1998 was 1.36, including all sheep breeds.

Fig. 4

Period between parities in the Improved Jezersko-Solcava breed across flocks in 1998



4. Abbildung: Zeitraum zwischen den Paritäten beim Genotyp Veredelte Jezersko-Solcava in den verschiedenen Herden im Jahre 1998

Zeitraum zwischen den Paritäten (PBP) Tage(1), Herde(2)

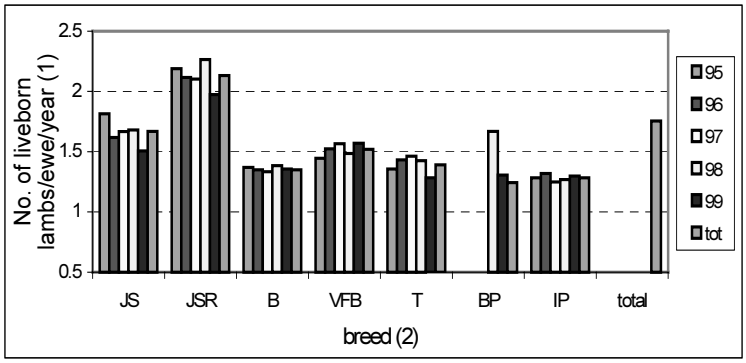
Number of lambs per ewe per year

The parameter 'number of lambs born per ewe per year' is composed on the basis of the parameters relating to litter size (number of lambs born) and number of litters per ewe per year. It is a more integral indicator of reproductive productivity of breeding animals.

Fig. 5 shows the number of young born alive per ewe per year for the entire controlled population in the last five years. The Improved Jezersko-Solcava Sheep ranked by far the highest with 2.13 young born alive per ewe per year, followed by the Jezersko-Solcava with 1.6. The value recorded for the Texel (1.39) fell between those for the Bovec Improved (1.5) and the Bovec Sheep (1.3). The extensive Zackels produced 1.2 lambs per ewe.

Fig. 5

The number of liveborn lambs per ewe per year across breeds from 1995 to April 1999



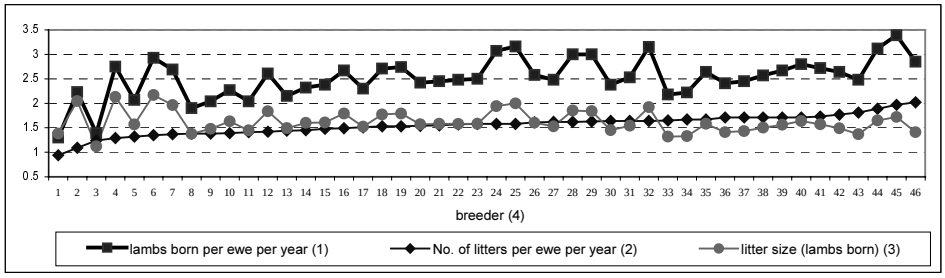
5. Abbildung: Anzahl der lebend geborenen Lämmer pro Mutterschaf bei den verschiedenen Genotypen in den Jahren 1995 bis 1999

Anzahl der lebend geborenen Lämmer/Mutterschaf/Jahr(1), Genotyp(2)

Litter size is a trait with low heritability, and selection yields slow improvements. Assuming fixed feeding and health conditions, the breeder has little influence on the number of young born in the litter. *Fig. 6* offers an illustration of how the period between parities (or number of litters per ewe per year) affects the number of young born per female per year. Breeders within the same breed (the figure shows Improved Jezersko-Solcava) achieve highly varying results.

Fig. 6

The influence of the number of lambings per ewe per year and litter size on the number of lambs born per ewe per year, demonstrated across the flocks of the Improved Jezersko-Solcava breed



6. Abbildung: Einfluss der Ablammungszahl pro Mutterschaf/Jahr auf die Lämmerzahl pro Ablammung, gezeigt an den Herden der Veredelten Jezersko-Solcava

Geborene Lämmer pro Mutterschaf/Jahr(1), Zahl der Ablammungen pro Mutterschaf/Jahr(2), Geborene Lämmer pro Ablammung(3), Züchter(4)

FERTILITY OF GOATS IN SLOVENIA

Goat keeping in Slovenia is mainly aimed at milk production. The flocks included in the milk recording scheme involve the goat breeds Saanen and Alpine. In 1999 breeders started to show interest in the Boer meat breed. Second to milk yield, fertility is a very important output in goat production, even in dairy breeds. The dairy breeds Saanen and Alpine are seasonally fertile, while the meat breed Boer is continuously fertile.

Fertility is monitored in herds with over 20 dairy or over 30 meat animals. In 1998 114 goat flocks were included in the recording scheme, producing 1089 litters. The results are shown in *Table 3*. The average age of goats at kidding was 4 years, and 17 % produced their first litters in that year. The youngest breed was the Boer. The breed has recently been introduced into Slovenia and was included in the breeding programme in 1998. The population is still low, located in a few flocks.

The average parity of goats in Slovenia in 1998 was 3.62. The average period between parities (PBP) was 371 days, which is to be expected for seasonal breeding. The meat breed Boer had a PBP of 281 days. The average litter size was 1.73 (born) and 1.67 (born alive). The goats produced 1.7 kids per female per year. The result for the Boer differed, at 2.29 kids per female per year.

Table 2

Goat fertility results in controlled flocks in Slovenia in 1998

Breed (1)	No. of flocks (2)	No. of litters (3)	No. first litters (4)	Age at lambing (years) (5)	Parity (6)	Age at first lambing (7)	Period between parities (8)	Lambings per fertile ewe pre year (9)	Litter size (born) (10)	Litter size (live) (11)	Lambs born per fertile ewe per year (12)
Total (13)	**1081**	**114**	**1089**	**186**	**4.00**	**3.62**	**528 1.45**	**371**	**1.73**	**1.67**	**1.70**
Saanan	259	38	259	36	4.40	3.96	490 1.34	385	1.77	1.74	1.68
Alpine	761	64	762	124	4.00	3.67	544 1.49	367	1.70	1.64	1.69
Boer pasma	51	12	58	24	2.09	1.47	505 1.38	281	1.76	1.71	2.29

2. Tabelle: Fruchtbarkeitsergebnisse bei Ziegen in den kontrollierten Herden Sloweniens im Jahre1998

Genotyp(1), Anzahl der Herden(2), Geborene Ziegenlämmer gesamt, Stück(3), Gesamtzahl der Ziegenlämmer bei 1. Ablammung(4), Durchschnittl. Ablammungsalter pro Mutterziege, Jahre(5), Parität(6), Alter der Mutterziegen bei 1. Ablammung, Tage(7), Zeitraum zwischen den Paritäten, Tage(8), Zahl der Ablammungen pro Mutterziege/Jahr(9), Anzahl der geborenen Ziegenlämmer pro Geburt(10), Anzahl der lebenden Ziegenlämmer/Geburt(11), Lämmerzahl pro Mutterziegen/Jahr(12), Gesamt(13)

The number of kids born and reared per female per year depends on a number of environmental effects, for instance nutrition, the milking and mothering abilities of the dam, fitness of the young, health, stress, technology, management and other factors. Heritability is generally low, but varies between breeds. The environmental circumstances affect the number of ovaries ovulating and undergoing conception, and also the number of young born, born alive and weaned. *Figures 7 and 8* show the number of kids born and born alive per litter in 1998 for both breeds. It is evident that breeders attain highly varying results, even within the same breed.

CONCLUSIONS

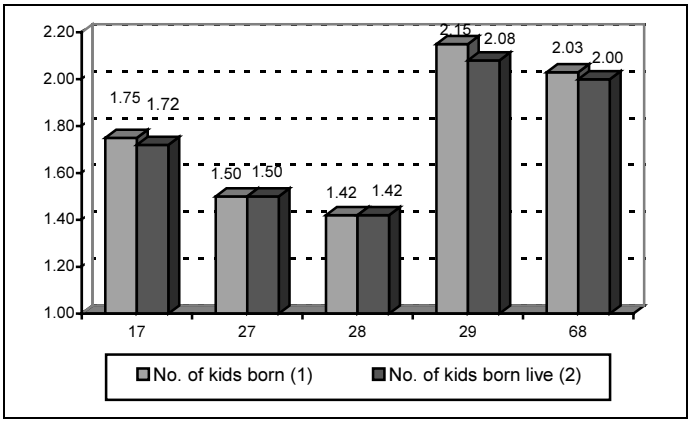
The initial review of lamb production evaluation parameters and the investigation of applicability to the Slovenian small ruminant breeding programme gave a list of parameters that may be used with a sufficient level of confidence. It also showed that the most informative parameters are not adequately reliable due to the unsatisfactory or uncertain quality of certain data records. The deficiencies exposed in data flow indicate where effort towards improvement needs to be applied.

Lamb production in sheep and goats, analysed in accordance with the parameter definitions described, has generally shown slight improvements over the past five years. However, the results indicate that there is still margin for improvement. Besides selection, which gives slow but long-term improvement, good flock management, proper nutrition and health condition can bring results in the short term. There are also expectations in the improvement of information about animals, which would help the

keeper to respond more promptly with management action. It is up to the breeder to be accurate with data recording and the extension service to assist other breeders and the breeding programme office to provide reliable measures of herd productivity.

Fig. 7

Number of kids born and liveborn in a litter in 1998 in the Saanen goat

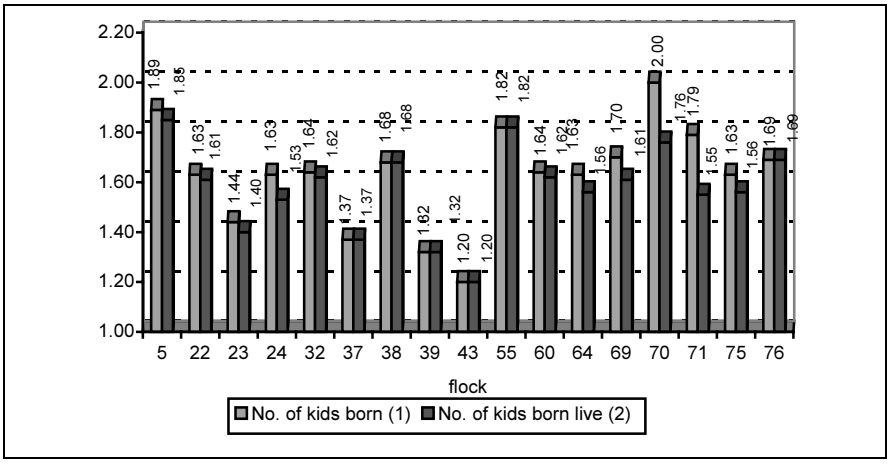


7. Abbildung: Zahl der geborenen und lebend geborenen Ziegenlämmer pro Ablammung bei den Saanen-Ziegen im Jahre 1998

Anzahl geborene Ziegenlämmer(1), Anzahl der lebend geborenen Ziegenlämmer(2)

Fig. 8

Number of kids born and liveborn in a litter in 1998 in the Alpine goat



8. Abbildung: Zahl der geborenen und lebend geborenen Ziegenlämmer pro Ablammung bei den Alpen-Ziegen im Jahre 1998

Anzahl geborene Ziegenlämmer(1), Anzahl der lebend geborenen Ziegenlämmer(2)

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