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ORIGINAL RESEARCH

Effect of management on reproductive performances of the Achai cattle in the Hindu Kush (Northern Pakistan)

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Abstract This study evaluates the effect of management on the undocumented Achai cattle reproductive performance in transhumant farming systems (TFS) and in sedentary farming systems (SFS) in northwestern Pakistan. Data were collected from 172 households in TFS and 270 households in SFS to analyze the effect of farming systems, parity, and calving season on key reproductive traits. The results show that farming systems significantly affect pubertal age, while parity has no significant effect on any of the key traits. The calving season significantly affects the postpartum anoestrus interval in TFS only. More than 50% of the cows in both systems have postpartum anoestrus intervals and calving intervals within the recommended values for cows in tropical countries. Achai cows have high first-service conception rates (70% and 71% for TFS and SFS, respectively) and require a relatively small number of services per conception (1.53±0.06 and 1.48± 0.05 SE for TFS and SFS, respectively). This local breed thus warrants conservation under both farming systems.

Keywords Animal genetic resources · Achai cattle · Reproductive performance · Parity · Farming systems

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Introduction

Reproduction is negatively correlated with milk yield. In the last 60 years, poor reproductive performance has thus become a global dairy industry issue (Refsdal 2007; Oltenacu and Broom 2010). Many countries have therefore started including female fertility in breeding goals (Chang et al. 2006).

Since indigenous breeds in developing countries often have better reproductive performance while being bred in harsher environments (Mulindwa et al. 2006; Phung 2009), it is important to preserve these animal genetic resources. Reproduction traits are also critical to predict milk yields, herd longevity, availability of replacement stock, and opportunities for more selective culling (Evans et al. 2006; Chang et al. 2006). In order to prevent the loss of valuable reproductive traits of indigenous breeds and to make their conservation possible, scientific documentation is crucial (FAO 2007; Kohler-Rollefson et al. 2009).

The Achai is an as yet undocumented but well-adapted indigenous cattle breed of the Hindu Kush Mountains (Khan 2004; Khan et al. 2008), and reared in both transhumant farming systems (TFS) and sedentary farming systems (SFS). Its petite body size allows Achai bulls to plough small terraces, while Achai cows produce sufficient homestead milk for a family. The breed also produces

significantly more offspring compared to imported breeds that are available for sale and slaughter (Rahim and Viaro 2002; Khan 2004). However, due to the concentrated efforts to increase milk production through cross-breeding, there is a danger of losing other important traits by neglecting the conservation of pure Achai cattle as important animal genetic resources (Khan 2004).

To prevent this loss and allow for conservation measures, a state-of-the-art characterization of important traits is needed. Studying the effects of environmental factors like calving season, parity, and farming systems on reproductive performance can furthermore assist in improving the breed and providing insights for its conservation (Kanuya et al. 2006; Hammoud et al. 2010). This study's objectives are (1) to explore the effect of farming systems on reproductive performance of the Achai cattle and (2) to evaluate the effect of parity and calving season on reproductive performance of this local breed.

Materials and methods

Home tract, study area, and attributes of farming systems

The broader home tract of the Achai cattle is spread over the northwestern Hindu Kush Mountains of Khyber Pukhtunkhwa (Fig. 1).

Under TFS, Achai herders spend summers in the uplands of Swat, Dir and Indus Kohistan, and winter in the major sugarcane growing lowlands of Peshawar valley. The transhumant system that rotates between the Gabral uplands and the Mardan lowlands was taken as a representative area for the study. The herders take dry cows, heifers, and bulls to the high pastures for grazing and keep milking cows at the settlements in the valley bottoms for homestead use. Milking cows are taken for grazing daily to the hillsides near the settlements. In the lowlands, sugarcane tops and maize stover are fed during winter, and are complemented with grazing along the canal sides and on stubble fields. The average herd size is about seven animals. The breeding season spreads over the entire year. However, the majority of cows come into heat during summer. In both the uplands and lowlands, cows are served with the available Achai bulls. Heifers are kept as replacement stock or sold, thus receiving better nutrition.

The SFS spreads over the remaining mountain and rainfed areas of Khyber Pukhtunkhwa. The district of Lower Dir was taken as the study area for SFS. Seasonal feeding, known as a cut-and-carry system, consists of: wheat straw, weed thinning, and hay in spring; wheat straw, tree leaves, and hay in summer; wheat straw, maize stalks, and weed thinning in fall; and wheat straw, maize stalks, and hay in winter. Farmers also graze their cows on stubble fields and on nearby hill slopes during the daytime. The average herd size is four animals. The cows are in heat from May until September. Almost 57% of the Achai cows are bred through natural breeding, whereas the rest are inseminated with semen from exotic cattle breeds (Khan 2004). Calves in both the systems are fed two quarters of the udder during the first month of life, one quarter during the second month, and half a quarter during the third. After that, calves are only allowed to suckle the dam for milk let down.

Sampling

Data were collected in the Gabral valley from 172 households for TFS, and in the Jandool, Maidan, and Talash valleys from 270 households for SFS through a structured questionnaire (see Table 1).

The postpartum anoestrus interval was taken as the interval from calving to first oestrus and the oestrus detection by farmers was based on bellowing, restlessness, mounting on other cows, and mucus discharge from vulva. The first service conception rate and the number of services per conception were calculated according to Fetrow et al. (1990). Data on reproductive performance were grouped according to parity and calving season in order to study the effect of these factors in both farming systems.

Statistical analysis

Student's t test was used to analyze the effect of farming systems on puberty age, postpartum anoestrus interval, calving interval, and number of services per conception. One-way analysis of variance with Tukey's multiple comparison post hoc test was used to analyze the effect of parity and calving season on postpartum anoestrus interval, calving interval, and number of services per conception.

Results

Effect of farming systems on reproductive performance

Results shows that Achai cows of TFS reach puberty at an earlier age than Achai cows of SFS (1,056.6±16.21 days, n=114 and 1,147.73±18.26 days, n=97; P<0.01), while differences for the mean postpartum anoestrus interval, calving interval, first service conception rate, and number of services per conception between TFS and SFS are nonsignificant.

The frequency distribution of the reproductive performance (Table 2) reveals that more than half of the studied Achai cow population resumes their cyclic activity within

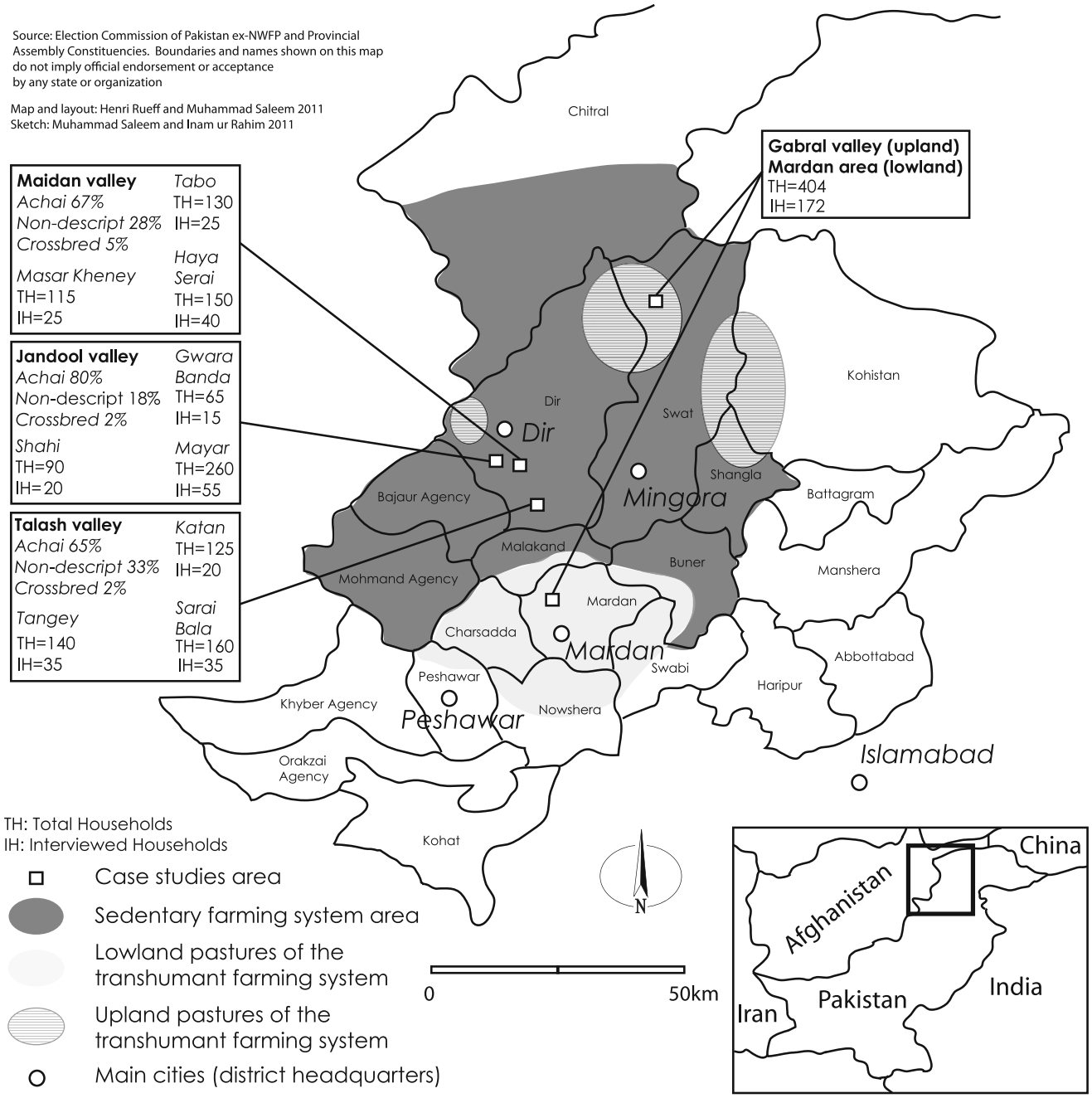

Fig. 1 Map of the study area and locations of surveyed villages

90 days postpartum in both TFS (54.96%) and SFS (59.63%). The majority of cows have calving intervals in the range of 360–450 days, both in TFS (52.76%) and SFS (56.99%).

Effect of parity and calving season on reproductive performance

There is no apparent significant effect of parity on the postpartum anoestrus interval, calving interval, first-service conception rate, or number of services per conception in both farming systems.

Calving season has no significant effect on the postpartum anoestrus interval in SFS, but it significantly affects the postpartum anoestrus interval in TFS ($F_{(3,\ 237)}=4.54$, $P<0.01$). The postpartum anoestrus interval ($P<0.05$) is longer in spring as compared to summer calvers (Fig. 2). However, the effect of calving season is nonsignificant on the calving interval, the first-service conception rate or the number of services per conception in both of the farming systems.

Table 1 Number of cows traced for different reproductive performances in TFS and SFS

Reproductive characteristics	TFS	SFS
Puberty age	114	97
Postpartum anestrous interval	242	161
Calving interval	253	279
First service conception rate	247	276
Services per conception	247	276

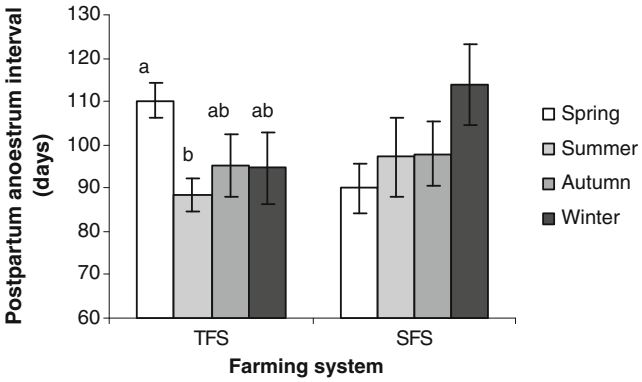

Fig. 2 The seasonal postpartum anoestrus interval of Achai cows in TFS and SFS. *Bars* show the standard error of the mean interval length values. *Different letters above bars* indicate differences in mean values among seasons in the TFS system (post hoc Tukey test, $P<0.05$)

Discussion

The significantly earlier arrival to the age of puberty of Achai cows in TFS could be due to better fodder availability, and hence better nutrition (Rekwot 2004) at upland pasture areas. Another possibility for earlier puberty is bull biostimulation (Oliveira et al. 2009), as heifers are grazed jointly with the bulls. In SFS, heifers received little attention in intensive feeding, which may be a cause of the late onset of puberty (Kumaresan et al. 2009). The nonsignificant effect of parity on reproductive performance may be due to the adaptability of Achai cows to environmental conditions, thus alleviating the adverse effect of environmental factors (parity) on reproductive traits (Salah and Mogawer 1990).

The longer postpartum anoestrus interval ($P<0.01$) for cows calved in the spring season in TFS, as compared to in the summer, may be due to fodder shortage (Montiel and Ahuja 2005) during the winter. In late spring, cows in TFS face additional stress, with the transhumance to the uplands causing a longer postpartum anoestrus interval. The significant effect of calving season on the postpartum anoestrus interval has also been reported in Sahiwal cows (Ahmad et al. 1989).

Reduction of the postpartum anoestrus interval early in the course of the year (winter to spring) in SFS than TFS (spring to summer) may be due to better fodder availability to cows in SFS in spring season than winter season (Rehman et al. 2008) as compared to cows in TFS where the stress of fodder shortage and transhumance that prolonged postpartum anoestrus interval in spring season is relieved when the cows arrived at upland pastures in summer season (Wright et al. 2002).

The attainment of puberty at later ages in Achai cows in comparison to Sahiwal and crossbred cows (Table 3) can be attributed to a combination of genetic factors (Nogueira 2004), poor nutrition (Bhatti et al. 2007), and poor management (Kumaresan et al. 2009).

The better reproductive performance of the Achai cattle compared to Sahiwal, Holstein Friesian, and crossbred cattle (Table 3) may be due to a balanced selection by farmers who keep in view both production and reproduction. The male offspring are reared as bulls for plough and sale, and the female offspring are reared for replacement and sale. On the other hand, selection based only on higher milk yields in Sahiwal, Holstein Friesian, and crossbred cows may have led to suboptimal reproductive performance, as milk yield is negatively correlated with reproduction (Oltenacu and Broom 2010).

The Achai cattle breed have evolved through a long-term selection process by subsistence mountain farmers. It thus fits the criteria of an ideal cattle breed put forward by Mulindwa et al. (2006). According to him, cattle breeds

Table 2 Frequency distribution of reproductive performance of Achai cows in TFS and SFS

Reproductive performance	Interval (days)	TFS		SFS	
		n	Frequency (%)	*n*	Frequency (%)
Puberty age	720–1080	78	68.42	43	44.33
	1,081–1,440	36	31.58	54	55.67
Postpartum anoestrus interval	40–90	133	54.96	96	59.63
	91–140	73	30.16	36	22.36
	>140	36	14.88	29	18.01
Calving interval	360–450	134	52.76	159	56.99
	451–540	88	34.65	73	26.16
	>540	32	12.59	47	16.85

Table 3 Comparative reproductive performance of Achai cattle in Pakistan

Variables	Achai[a]	Sahiwal	H. Friesian	Crossbred
Age at puberty (days)	TFS=1,056.60±16.21 SFS=1,147.73±18.26	1,041.88±51.99[b]	625.40±14.65[e]	752±10.90[i]
Postpartum anoestrus interval (days)	TFS=101.50±2.59 SFS=96.27±3.37	160.04[c]	113.34±3.45[f]	106.5±3.4[j]
Calving interval (days)	TFS=480.24±5.03, SFS=476.37±5.17	464±2.5[d]	567.8±21.91[g]	612±4.56[i]
First service conception rate (%)	TFS=70.04, SFS=71.01	57.38[b]	66.52[b]	54.48[b]
Number of services per conception	TFS=1.53±0.06, SFS=1.48±0.05	2.13[c]	2.89±0.10[h]	1.60±0.1[i]

[a] Present study
[b] Qureshi et al. (2008)
[c] Ali et al. (1992)
[d] Rehman et al. (2008)
[e] Sandhu et al. (2011)
[f] Sattar et al. (2005)
[g] Niazi and Aleem (2003)
[h] Ali et al. (2011)
[i] Qureshi et al. (2000)
[j] Chaudhry and Usmani (1986)

for several farming systems in the tropics is one that is capable of providing moderate milk yield, meat, and draft power, while feeding on a predominantly roughage diets.

Crossbreeding appears as the major cause for losing pure SFS Achai cattle genetic resources, especially in accessible areas. According to the record of the Directorate of Breed Improvement in Khyber Pukhtunkhwa, during the period 2005–2010, 0.14 million Achai cattle have been inseminated with semen from exotic breeds in Dir and Swat valleys.

Conclusions

1. The significantly earlier puberty age of Achai cows in TFS shows the impact of traditional breeding management on puberty. Herds in TFS being larger, there is a wider choice to select animals compared to SFS herds. It also shows that the transhumant herds are a better source, as compared to sedentary herds, for selecting animals with important reproductive traits, if the development of a nucleus herd for in situ conservation is foreseen.
2. The significant early arrival at puberty in TFS also shows that the breed evolving in an extensive system achieves better performance. This probably also indicates that the breed is better adapted to a transhumant system.
3. The significant effect of calving season on the postpartum anoestrus interval in TFS warrants improvement in feeding management during the winter season to alleviate the negative effect on the postpartum anoestrus interval.
4. With comparatively better reproductive performance, the Achai cattle are an important genetic resource breed of mountain environments, which justifies its conservation. Further research is however needed in the following areas:
   (a) The endocrine measures of fertility, such as: the commencement of luteal activity postpartum, the life span of corpus luteum, and the pattern of estrus cyclicity to enable for selecting cattle for improved fertility.
   (b) The causes of long calving intervals for possible intervention to optimize the length of this trait.

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