The Journal of Animal and Plant Sciences, 22(3 Suppl.): 2012, Page: 347-352
ISSN: 1018-7081

GENETIC AND PHENOTYPIC PARAMETERS FOR GROWTH TRAITS OF NILI-RAVI BUFFALO HEIFERS IN PAKISTAN

P. Akhtar, U. Kalsoom, S. Ali, M. Yaqoob*, K. Javed**, M. E. Babar**, M. I. Mustafa* and J. I. Sultan*

Department of Animal Breeding and Genetics, *Department of Livestock Management, Faculty of Animal Husbandry, University of Agriculture, Faisalabad, Pakistan
**Department of Livestock Production, University of Veterinary & Animal Sciences, Lahore, Pakistan
Corresponding author e-mail: drpervez_1@yahoo.com

ABSTRACT

Data on body weights at different ages of 624 Nili Ravi buffalo heifers from 243 dams and sired by 48 sires kept at LES, Bahadurnagar, Okara, Pakistan were collected from 1989 to 2002 and analyzed by using DFREML (Derivative Free Restricted Maximum Likelihood) in this study. Average weights at birth, weaning, yearling, Pre-weaning average daily gain were 35.86±4.30 kg with CV of 11.99%, 66.12±9.16 with CV 13.85%, 145.82±19.50 with CV of 13.37%, 316.47±88.33 g for Nili-Ravi female calves, while average post-weaning daily gain was 297.66±31.03 g. Average weight at 2 years of age in heifers was 240.05±25.10 kg and average 3 years weight was 329.73±23.17 kg. ANOVA indicated significant effect of birth year, season of birth, age and weight of dam on the growth traits. Maximum weight was observed in spring season, while minimum weight was obtained in winter season. The maximum heritability was 0.25±0.14 for birth weight while the minimum heritability was 0.16±0.75 for yearling weight. The heritability estimates for all growth traits were moderate to high suggesting that selection might be a good criterion for improvement. The phenotypic correlations ranged from 0.29±0.19 between birth weight and weight at 36 month's age and 0.76±0.16 between weaning weight and weight at 12 month's age. The maximum environmental correlation was 0.83±0.20 between 12 months weight and weight at 24 months of age while it was minimum as 0.23±0.11 between weaning weight and weight at 36 months of age. The highest genetic correlation was 0.62±0.09 between birth weight and weight at 24 months of age whereas minimum genetic correlation was 0.25±0.12 between 12 months weight and weight at 36 months of age. In general correlations were fairly large and positive indicating that selecting one trait will positively affect the other trait.

Key words: Genetic parameters, Growth traits, Buffalo heifers, Pakistan.

INTRODUCTION

Nili-Ravi buffalo is a dynamic breed under the field conditions of Pakistan and is ranked as an important dairy breed of buffalo. In selection of breeding animals, it is important to determine their prospective value at an early age. A study of birth weight as a measure of prospective value of calf is therefore justified since it is one of the first measures that can be obtained and also one of the easiest to record with reasonable accuracy. If phenotype at an early age is an expression of genotype, it should be possible to select superior individuals on the basis of their early performance. For a successful breeding program, an understanding of the degree of genetic, phenotypic and environmental association among traits is essential (Massey & Benyshek 1982). Estimates of heritability and genetic correlation between body weights at early ages with market and mature body weight will be needed for deciding the selection criteria and for predicting the expected genetic gain by their use (Chopra & Charya 1971). The genetic selection for growth traits of an animal at an early age will reduce the age at first calving, low cost of production, better fertility and starts producing milk at an early age which is an important economic factor for the farmer. The present study was planned to evaluate and estimate the extent of environmental influences and to estimate the genetic parameters for growth traits in Nili-Ravi buffalo heifers.

MATERIALS AND METHODS

Source of data: Data on pedigree and body weights at different ages of 624 Nili Ravi buffalo female calves 243 dams which were sired from 48 sires, kept at the Livestock Experiment Station, Bahadurnagar, Okara, Pakistan, from 1989 to 2002 was collected and analyzed by using computer programs LSMLMW (Mixed Model Least square and Maximum Likelihood) and DFREML (Derivative Free Restricted Maximum Likelihood Model) to investigate the genetic and phenotypic parameters of birth weight, weaning weight, yearling weight, pre-weaning daily gain, post-weaning daily gain and weight at 2 & 3 years of age. Effect of environmental factors i.e., year, season of birth, age and weight of dam on growth traits were evaluated. Year was divided into five different seasons i.e., winter (December-to-February); spring

(March-to-April); dry hot (May-to-June); humid hot (July-to-September) and autumn (October-to-November). The dams were grouped into six categories according to their weights. Data were checked critically for consistency of recorded information, dates, and animal identities. Records of animals with missing observations were eliminated from analyses. The data was edited in such a way that the records outside plus or minus 3 standard deviations from the phenotypic mean were eliminated. The number of records eliminated during this editing was less than 2.5 percent of the total number of records.

Background and location of the farm: The livestock farm was established in 1916 on 3, 049 acres of land leased out under the provision of colonization of Government Lands (Punjab) Act V of 1912. The condition of lease was to maintain 400 cattle of Hissar breed. In 1936 these animals were replaced with equal numbers of buffaloes of Nili and Ravi breeds. The main objective of the farm was to conserve and improve the existing breeds in the area. It was also aimed at producing pedigreed bulls for improving buffalo breed in area. After independence, lessee migrated to India and since then, farm is under the control of Government. The farm has been raised to the status of a research institute and it undertakes research on large scale. The area is canal irrigated with loamy soil. The climate is relatively dry and rains usually occur during the months of July-September. During summer months, day temperature may go as high as 47.5^{o}C and during winter night temperature may fall upto - 4^{o}C.

Since the establishment of this farm, the female stock was mainly selected on the basis of conformation and breed characteristics with little consideration to milk production. Due attention had not been paid to other dairy characteristics during the selection of these animals. The males with desired conformation and from the high yielding dams were retained at the farm for future breeding and this policy had been followed till 1980. From there on, some buffalo bulls were purchased to provide heterogeneity. Artificial insemination in this here was started during 1960. At present a programme of identification of buffalo bull mothers and progeny testing is also in progress.

The animals were maintained in open enclosures throughout the year. However, roofed shelters were provided to protect them from severe weather. The milking buffaloes, dry buffaloes, young calves, heifers and bulls were kept in separate barns. All animals were sent out for grazing from 8:00 a.m. to 2:00 pm. and were supplemented with additional fodder in paddocks. The calves were being weaned just 3-4 days after their birth and milk was fed with compound feeds. The buffaloes were milked twice daily at 3:00 A.M. and 3.00 P.M. The weaning of calves started in 1962 and prior to this the calves were allowed to suckle their dams. However, once a week the calves were not allowed suckle their dams and the animals were milked completely and this one day record was used to compute the total weekly milk yield. Heifers and dry buffaloes were mainly kept on green fodder and other roughages throughout the year. At the later stages of pregnancy, however, concentrates were also offered as a supplement. The buffaloes in milk were liberally fed on green fodder and roughage. Concentrate ration was given at the rate of 01 kg for maintenance and 01 kg for every 3 liters of milk produced.

The composition of feed varied according to the fodder crops available during the year. Green Jawar (*Andropogon sorghum*), maize (*Zea mays*), guara (*Cyamposis psoraliodes*), moth (*Phaseolus aconitifolius*) and peas (*Vigna sinensis*) were fed during the month of May to October. During Novemberto April, green berseem (*Trifolium alexandrium*), shaftal (*Trifolium renpinatum*), Lucerne (*Medicagor osativa*) and rape mixture (*Brassica napus*) were mainly given to these animals. Dry fodder comprised of the stovers of bajra (*pennisetum typhoideum*) maiz (*Zea mays*) and wheat bhoosa (straw of *Triticum* species). The concentrate mixture was composed of crushed cakes (cotton seed, rape seed etc.). Lumps of common salt (*Sodium chloride*) were provided in mangers for free choice licking. The standard of feeding was reported to have been maintained, although it may have fallen when there was shortage of concentrates and fodder.

Statistical analyses:

Evaluation of environmental effects: The mathematical model assumed was: $Y_{ij} = \mu + F_i + e_{ij}$ (Model 1)

where, Y_{ij} = Measurement of particular trait; μ = Population mean; F_i = Effect of all fixed effects (birth year, season of birth, age and weight of dam) with e_{ij} = Random error with mean zero and variance σ^2_e.

Estimation of genetic parameters: The genetic parameters i. e. heritability, repeatability and genetic correlation were estimated by using Restricted Maximum Likelihood Procedure outlined by Patterson and Thompson (1971) fitting an individual animal model. The mathematical model assumed for heritability estimation was:

$Y_{ijk} = \mu + F_i + A_j + e_{ijk}$ (Model 2)

where, A_j = Random additive genetic effect with mean zero and variance σ^2_A. Phenotypic variance (σ^2_P) = Additive genetic variance (σ^2_A) + Residual variance (σ^2_e). The heritability was calculated as;

Heritability (h^2) = σ^2_A / σ^2_P

The repeatability estimates for weight at different ages were assumed by the following mathematical model:

$Y_{ijk} = \mu + D_i + F_j + e_{ijk}$ (Model 3)

Where; D_i = the random effect of i^{th} dam. The estimated common environmental parameter (c^2) represents the proportion of phenotypic variance (σ^2_P) attributed to permanent environmental variance (σ^2_{PE}) and was calculated as: $c^2 = \sigma^2_{PE} / \sigma^2_P$

Repeatability of concerned trait was estimated as:

$R = (\sigma^2_{A} + \sigma^2_{PE})/\sigma^2_P$

where, additive genetic variance = σ^2_A.The model includes animal's permanent environmental effect in addition to the animal's additive genetic effect and the residual effect assuming that it is uncorrelated to other random effects i.e. additive genetic and residual effects. In this case animal's permanent environmental effect was fitted as additional random effect.

For the estimation of genetic correlation, bi-variate analyses was carried out by using Restricted Maximum Likelihood Procedure (Patterson & Thompson 1971) fitting an individual animal model by using Derivative Free Restricted Maximum Likelihood Model (DFREML) set of computer programs by Meyer, (1997). Fixed effects affecting weights of heifers were same as in the uni-variate analyses. (Model 2).

The various parameters from this bi-variate analysis were:

Heritability (h^2_i) = $\sigma^2_{ai} / \sigma^2_{Pi}$;

Genetic correlation (r_G) = Cov $a_i \cdot a_j$ / σ $a_i \cdot \sigma$ a_j

Phenotypic correlation (r_P) = Cov $p_i \cdot p_j$ / $\sigma_{pi} \cdot \sigma$ p_j and

Residual correlation (r_e) = Cov $e_i \cdot e_j$ / σ $e_i \cdot \sigma$ e_j

where, h^2_i = heritability of i^{th} trait; σ^2_{ai} = additive genetic variance of i^{th} trait;

σ^2_{Pi} = phenotypic variance of i^{th} trait; σ^2_{ei} = Residual variance of i^{th} trait;

Cov $p_i \cdot p_j$ = phenotypic co variance for the traits i and j;

Cov $a_i \cdot a_j$ = additive genetic co variance for the traits i and j;

Cov $e_i \cdot e_j$ = residual co variance for the traits i and j

RESULTS AND DISCUSSION

The overall mean, standard deviation and coefficient of variation of different growth traits in Nili-Ravi buffalo calves are given in Table 1. The average birth weight of calves born during 1989-2002 was 35.86±4.30 kg. The average weaning weight at 90 days was 66.12±9.16 kg with a coefficient of variation 13.85%. The pre-weaning average daily gain in calves was 316.47±88.33 g with a coefficient of variation 27.91%. The average post-weaning daily gain was 301.21±29.14 g with a coefficient of variation 9.39%.

Environmental factors affecting performance traits: The environmental factors (birth year, season of birth, age and weight of dam) significantly (**P** < 0.05) affected the birth weight. The least square means (LSM) for birth weight ranged from 31.25±0.13 to 36.31±0.96 kg in the calves born during 1989-2002. Highest birth weight (36.31±0.95 kg) was observed in 1989 while it was lowest (31.25±0.13 kg) among birth weights in 1997. The birth weight ranged from 33.22±0.13 to 38.13±0.91 kg in the calves of dams with 5 to 12 years of age. Highest birth weight (38.13±0.91 kg) was in dams with 10 years of age while it was lowest (33.22±0.13 kg) in dams with five years of age. The LSM for birth weight ranged from 31.36±1.39 to 38.66±0.17 kg in the calves from the dams with different weights (330 - >600 kg). Highest birth weight (38.66±0.17 kg) in calves was observed from the dams of 500-550 kg while it was lowest (31.66±1.39 kg) from the dams of 330-400 kg.

The effects of all fixed factors on weaning weight of calves were significant (P < 0.05). The LSM for weaning weight fluctuated between 54.10±1.13 kg and 77.25±0.63 kg in the calves born during 1989-1999. Highest weaning weight (77.25±0.63 kg) was observed in calves born in 1995 while it was lowest (54.10±1.13 kg) in the calves born during 1999. The weaning weights ranged from 60.11±1.59 kg to 88.45±1.57 kg in the calves of dams with 5 to12 years of age. Highest weaning weight (88.45±1.57 kg) was in dams with five years of age.

The analysis of data indicated that the effects of year, season and weight of the dam were significant (P < 0.05) on yearling weight. The LSM for yearling weights ranged between 122.15±2.71 kg and 184.24±2.12 kg in the calves born during 1989-1999. Highest yearling weight (184.24±2.12 kg) was in 1989 while it was lowest (122.15±2.71 kg) in 1993. The effects of year, season of birth, age of the dam and weight of dam on pre-weaning average daily gain of calving were significant (P < 0.05). It fluctuated between 185.35±10.87 g and 495.53±14.56 g in calves born during 1989-1999. The highest pre-weaning daily weight gain (495.53±14.56 g) was obtained during 1995 while it was lowest (185.35±10.87 g) in 1998. Pre-weaning average daily gain was highest (421.06±18.19 g) in calves born in spring season while it was lowest (313.36±12.10 g) among winter born calves. The LSM for pre-weaning average daily gains was highest (445.46±17.11 g) from dams with 550-600 kg while it was lowest (160.12±11.98 g) from 330-400 kg dams. The effects of year of birth, season of birth and age of dam at calving were significant (P < 0.05) on Post weaning average daily gain. The LSM for daily gain from three to six months fluctuated between 161.10±105.17 g and 492.25±11.14 g in calves born during 1989-1999 and varied significantly (P < 0.05). The LSM for three to six months gain of calves ranged from 216.15±18.22 g to 339.25±17.19 g in the calves born in different seasons. Highest gain was (339.25±17.19 g) in spring season while it was lowest (216.15±18.22 g) in the calves born during dry hot season. The LSM for three to six months gain ranged from 176.26±10.58 g to 299.06±18.68 g in the calves from dams with different weights (330->600 kg). Highest gain (299.06±18.68 g) was observed in calves from the dams with 400-450 kg while it was lowest (176.26±10.58 g) from 550-600 kg dams.

The results of the present study are in agreement with the studies of environmental effects on growth traits by different workers (Aman et al. 1985; Thevamanoharan et al. 2001; Gaertner et al 1992). The significant variation in the present study during different years in birth weight of calves reflected the level of management, availability of good quality feed in sufficient quantity as well as some environmental effects like temperature and humidity in different years. The level of management is bound to vary according to ability of farm manager, his system of crop husbandry, methods and intensity of culling, his efficiency in the supervision of farm labor as well as in utilization of financial resources. Birth weight and weaning weight were reported to be significantly affected by year of birth ($P < 0.01$) in Swamp buffalo (Thevamanoharan et al. 2001). The effect of year and season of birth significantly affected weight gain of Mashona cattle on range in Zimbabawe (Tawonezvi 1989). However, the effect of season as in the present study is not in agreement with some workers (Nautiyal & Bhat 1989; Euclides et al. 1991). The significant effects of age of the dam (Table 2) as obtained in the present study are in agreement with others (Tawonezvi 1989; Erb et al. 1981; Dhumal et al. 1988).

Genetic factors affecting performance traits

Heritability & Repeatability estimates: The estimates of heritability for birth weight, and weaning weight were 0.25±0.14 and 0.17±0.21 respectively while the repeatability estimates for birth weight and weaning weight were 0.29±0.09 and 0.41±0.51 respectively (Table 2). Heritability estimates ranging from 0.11-0.40 have been reported in various breeds of buffaloes by many workers (Euclides et al. 1991; Singh & Basu 1988; Ayyat et al. 1997; Bullocks et al. 1992; Bullocks et al. 1993). The results of the present study revealed the heritability estimate of 0.17±0.21 for weaning weight of Nili-Ravi buffalo calves (Table 2). These estimates are not in agreement with earlier report (Bullocks et al. 1992) depicting the higher heritability estimates (0.59 to 0.67) for weaning weight calculated by paternal half sib correlations. However, low heritability estimates (0.00 to 0.16) calculated by half-sib correlations and paternal half sib correlations on the buffalo crosses and Swamp buffaloes were reported (Euclides et al. 1991; Bullocks et al. 1993). Heritability estimate of 0.16±0.75 was revealed from the data of Nili-Ravi calves for weight at one year of age (Table 2). This low estimate of heritability indicates that improvement through selection is not a feasible way of progress in this trait however improvement in management and environment would result into higher weights. Some workers (Bullocks et al. 1992; Bullocks et al. 1993) reported moderate estimates of heritability in Hereford cattle ranging from 0.23-0.27.

Repeatability estimates of birth weight observed in the present study is low as compare to repeatability for weaning weight that is 0.41±0.51. The result of present study indicates that weaning weight in Nili-Ravi calves is highly repeatable. Hence improvement in this trait through selection could provide encouraging results. Repeatability estimates for weight at one year of age in the present work is 0.49±0.05.

Table 1 Overall means, standard deviations (S.D.) and Co efficient of variation (C.V. %) of various growth traits in Nili-Ravi Buffalo calves.

Growth Traits	Mean ± S.D	C.V. %
Birth Weight (kg)	35.86±4.30	11.99
Weaning Weight (kg)	66.12±9.16	13.85
Pre-weaning average daily gain (g)	316.47±88.33	27.91
Post-weaning average daily gain (g)	301.21±29.14	9.3.9
Yearling weight (kg)	145.82±19.50	13.37
Weight at 2 years (kg)	240.05±25.10	10.45
Weight at 3 years (kg)	329.73±21.17	6.42

Table 2 Heritability and repeatability estimates for growth traits in Nili-Ravi buffalo calves

Growth Traits	Heritability	Repeatability
Birth Weight	0.25±0.14	0.29±0.09
Weaning Weight	0.17±0.21	0.41±0.50
Yearling weight	0.16±0.75	0.49±0.05
Weight at 2 years of age	0.21±0.14	
Weight at 3 years of age	0.23±0.17	

Phenotypic and Genetic correlations: Phenotypic correlation between birth weight and weaning weight; weaning weight and yearling weight; yearling weight and pre-weaning average daily gain and yearling weight and post-weaning average daily gain are 0.41±0.11, 0.76±0.16, 0.67±0.16 and 0.69±0.20 respectively. The genetic correlation between birth weight and weaning weight is 0.81±0.16 (Table 3). Phenotypic and genetic correlations between weights at different ages in the present herd are positive and mostly high. This was expected, since a part-while relationship existed between each pair of trait. Genetic correlation between birth weight and yearling weight reported in the present study is 0.70±0.19 which is contradictory with the genetic correlations reported by Kress et al. (1986) as 0.27 in polled Hereford cattle. The estimates of genetic correlation between weaning weight and yearling weight in this study (0.67±0.17) are in agreement with the estimates of others (Kress et al. 1986; Kennedy & Henderson 1975).

Table 3 Phenotypic and genetic correlations among growth traits of Nili-Ravi buffalo calves

Description	Phenotypic Correlation	Environmental Correlation	Genetic Correlation
Birth weight and Weaning weight	0.41±0.11	0.32±0.10	0.81±0.16
Birth weight and Yearling weight	0.37±0.15	0.26±0.16	0.70±0.19
Weaning weight and Yearling weight	0.76±0.16	0.79±0.18	0.67±0.17
Yearling weight and Pre-weaning daily gain	0.67±0.16	0.57±0.09	0.65±0.16
Yearling weight and Post-weaning daily gain	0.69±0.20	0.47±0.11	0.73±0.18
Yearling weight and weight at 2 year of age		0.83±0.20	

Conclusions: A variation in the heritability estimates of the present study as well as reported by many other workers could be due to variation between breeds, herds and even between periods of time. A high heritability estimate for birth weight in this herd indicate that larger proportion of the phenotypic variation was due to effects of the genes and a smaller fraction was due to the environmental effects and the prospects of progress through selection within herd appeared to be very bright. This estimate indicate that there was less scope for improving birth weight through better feeding, management etc. So selection for higher birth weights can be recommended in this herd at least on short term basis. In general phenotypic and genetic correlations were fairly large and positive indicating that selection of one trait will positively affect the other trait.

REFERENCES

Aman, A. K., O. M. Arief and O. A. Shokri (1985). Variation in weights of Kedah-Kelantan cattle from birth to one year of age. Madri Research Bulletin13, 81-86. (Anim. Breed. Abstr., 1986; 54: 349.)

Ayyat, M. S., O. M. El-Shaffe, I. F. Marai, M. N. El-Gaafary, M. I. Tawfeek and M. I. El-Rajem (1997). Effects of inbreeding on some productive and reproductive traits of Egyptian buffaloes Proc. Intl. Conf. On Animal, Poultry and Rabbit Prod. and Health, Cairo, Egypt, 203-212.

Bullock, K. D., J. K. Bertrand and L. L. Benyshek (1993). Genetic and environmental parameters for mature weight and other growth measures in Polled Hereford cattle. J. Anim. Science 71, 1737-1741.

Bullock, K. D., J. K. Bertrand and L. L. Benyshek (1992). Heritabilities, genetic and environmental correlations for mature weight and other important production traits in a herd of Hereford cattle. J. Anim. Science 70, 81.

Chopra, S. C. and R. M. Charya (1971). Genetic and phenotypic parameters of body weights in Bikaneri sheep (Magra strain). Animal Production 13, 343-347.

Dhumal, M. V., P. G. Sakhare and K. S. Deshpande (1988). Factors affecting growth rate of local and Jersey × local calves. Indian J. Anim. Science58, 855-859. (Anim. Breed. Abstr., 1989; 57: 181.)

Erb, R. E., T. S. Stewart and T. G. Martin (1981). Relationship of pre-weaning growth traits of Angus calves with dairy character score and weight of dams. J. Anim. Sci. 53, 510.

Euclides, F. K., P. Nobre, R. C. Rosa and A. Don (1991). Age of cow and its interaction with herd, sire and sex of calf. Revista da Sociedade Brasileira de Zootecnia 20, 40-46. (Anim. Breed. Abstr., 1992; 60: 118.)

Gaertner, S. J., F. M. Rouquette, J. C. R. Long and J. W. Turner (1992). Influence of calving season and stocking rate on birth weight and on weaning traits of Simmental sired calves from Brahman × Hereford (F1) dams. J. Anim. Science 70, 2296-2303.

Kennedy, B. W. and C. R. Henderson (1975). Genetic, phenotypic and Environmental correlations among growth traits of Hereford and Aberdeen Angus calves. Can. J. Anim. Science 55, 503-507.

Kress, D. D., R. D. Scarth, R. L. Fiedrich and P. J. Burfening (1981). Genetic parameters for polled Hereford field data. J. Anim. Sci. 53, 142.

Massey, M. E. and L. L. Benyshek (1982). Genetic, phenotypic and environmental correlations among performance traits estimated from Limousin Field Data. J. Anim. Science 54, 46-50.

Meyer, K. (1997). User's notes of DFREML set of computer programs version 3.0.00α.

Nautiyal, L. P. and P. N. Bhat (1989). Body weight of Hariana crosses. Ind. J. Anim. Science 59, 1007-1010. (Anim. Breed. Abstr., 1990; 58: 269.)

Patterson, H. D. and R. Thompson (1971). Recovery of inter block information when block sizes are unequal. Biometrika 58, 545-554.

Singh, D. and S. B. Basu (1988). Genetic parameters of first lactation traits in Murrah buffaloes. Indian Vet. J. 65, 593-598.

Tawonezvi, H. P. R. (1989). Growth of Mashona cattle on range in Zimbabawe. 1) Environmental influences on live weight and weight gain. Tropical Animal Health and Production 21, 37-42. (Anim. Breed. Abstr., 1989; 57: 596.)

Thevamanoharan, K., W. Vandepitte, G. Mohiuddin and C. Chatalakhana (2001). Environmental factors affecting various growth traits of Swamp buffalo calves. Pakistan J. Agri. Sciences 38, 5-10.

Tumwasorn, S., T. A. Olson, C. J. Wilson, M. Koger and W. T. Butt (1986). Trend analysis of pre-weaning traits in Florida. J. Anim. Science 63, 4.