

## Prediction of stage of pregnancy in prolific sheep using ultrasound measurement of fetal bones

Paul L. Greenwood<sup>ACD</sup>, Ramona M. Slepetic<sup>A</sup>, Malcolm J. McPhee<sup>B</sup> and Alan W. Bell<sup>A</sup>

<sup>A</sup>Department of Animal Science, Cornell University, Ithaca, NY, USA.

<sup>B</sup>NSW Agriculture Beef Industry Centre, University of New England, Armidale, NSW 2351, Australia.

<sup>C</sup>Present address: NSW Agriculture Beef Industry Centre, University of New England, Armidale, NSW 2351, Australia.

<sup>D</sup>To whom correspondence should be addressed. email: paul.greenwood@agric.nsw.gov.au

**Abstract.** The use of ultrasound to estimate stage of pregnancy was assessed in 32 ewes of a prolific genotype carrying 7 singleton fetuses and 9 twin, 10 triplet and 6 quadruplet litters that were scanned on six occasions from 60 to 120 days of gestation. At least one ultrasound measurement per ewe of fetal metacarpal bone length (MCL), biparietal diameter (BPD), or of both bones was made on over 90% of attempts ( $n = 152$ ). Measurement of MCL was made on 78% of attempts ( $n = 371$ ), of BPD on 73% of attempts, and of both bones on 62% of attempts. The equation developed from BPD (mean absolute error (MAE) = 3.2 days) was similar to that developed from measurement of MCL (MAE = 3.3 days) in its capacity to predict stage of pregnancy. Accuracy of prediction was improved using equations that included mean values within litters for BPD (MAE = 2.5 days) and MCL (MAE = 2.6 days). Further improvement in predictive capacity was achieved using multiple regression equations developed from measurement of both bones (individual fetuses: MAE = 2.6 days; equations including mean values within litters: MAE = 2.2 days). The results demonstrate that ultrasound can be used to estimate stage of pregnancy in prolific ewes, and that the use of mean values for bone measurements from different fetuses within litters and/or measurement of bones with different growth allometry can increase the reliability of estimates. The utility of the procedure depends on the number of fetuses measured per ewe, the number of bones measured per fetus and, hence, the time required to measure bones and the degree of accuracy required.

### Introduction

Ultrasound has widespread application in obstetrics and gynaecology, including estimation of stage of pregnancy and fetal weight (Chervenak *et al.* 1993). In sheep, it is widely used to determine pregnancy status and the size of litters (White and Russel 1987), and has also been used to measure placental growth (Kelly *et al.* 1987). Associations between fetal age and external characteristics and/or measures of size have been determined post mortem and described for many species (Evans and Sacks 1973), including sheep (Wallace 1948; Joubert 1956; Richardson *et al.* 1976; McDonald *et al.* 1977). In the live sheep, measurement of fetal growth has been limited to surgical techniques to measure crown–rump length (Mellor and Matheson 1979) and thoracic girth (Mellor and Murray 1982). More recently, however, fetal growth retardation has been detected using ultrasound (Barbera *et al.* 1995; Galan *et al.* 1999; Greenwood *et al.* 1999).

The development of a method to accurately estimate the stage of pregnancy when precise mating dates are not available, particularly in prolific ewes, would assist management to maximize survival rates of offspring. Estimation of stage of pregnancy in sheep has been attempted using ultrasonographic measurements of size of placentomes. However, the relationship between these variables was poor

(Doize *et al.* 1997). Therefore, it appears that direct ultrasonographic measurement of fetuses is required to more accurately predict stage of gestation. The present paper reports and discusses the use of real-time ultrasound to measure fetal bones in order to predict the stage of pregnancy of prolific ewes during mid to late pregnancy.

### Materials and methods

#### *Experimental animals*

All procedures were performed with the approval of the Cornell University Institutional Animal Care and Use Committee. All fetuses were Suffolk × (Finn × Dorset) genotype. Fifty-five ewes were selected and managed as a flock at the Cornell University Mount Pleasant Sheep Farm. A vasectomized ram was maintained with the flock to identify ewes in oestrus, which were then segregated from the flock and mated to a Suffolk ram. All matings occurred within a 29-day period.

#### *Determination of pregnancy status and litter size*

Pregnancy status was diagnosed at about 40 days of gestation, and litter size was estimated at about 50 days by an experienced operator (R.M.S.) using an Aloka 210 ultrasound unit (Corometrics Clinical Systems, Wallingford, CT) fitted with a 3.5- or 5-MHz transducer.

#### *Management of ewes and post-mortem measurement of fetal bones and fetal weight*

Ewes ( $n = 32$ ) with singleton ( $n = 7$ ), twin ( $n = 9$ ), triplet ( $n = 10$ ) and quadruplet ( $n = 6$ ) litters were moved to the Cornell University Large Animal Teaching and Research Unit at approximately 50–60 days of