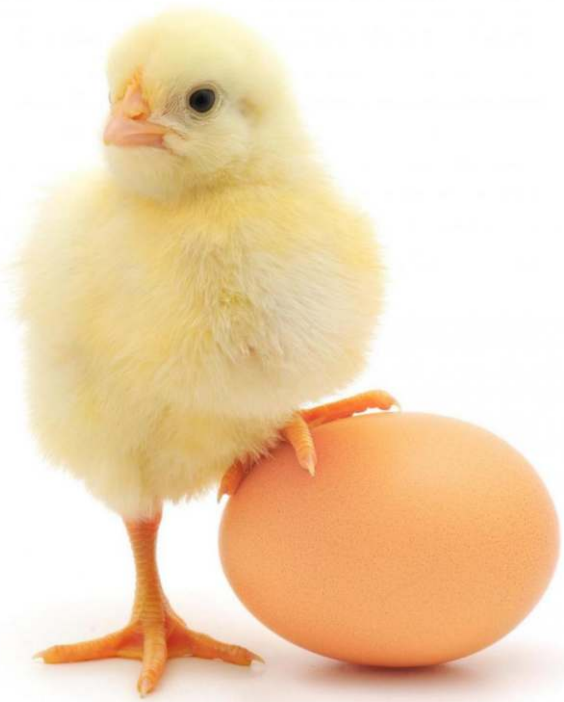
ISSN 1682-8356
ansinet.org/ijps



INTERNATIONAL JOURNAL OF POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 8 (7): 660-664, 2009
ISSN 1682-8356

A Retrospective Study of Egg Production, Fertility and Hatchability of Farmed Ostriches in Botswana

B.M. Dzoma[1] and K. Motshegwa[2]
[1]Department of Animal Health, North West University (Mafikeng), P.O. Box 2046, Mmabatho 2735, South Africa
[2]Department of Animal Science and Production, Botswana College of Agriculture, P.O. Box 0027, Gaborone, Botswana

Abstract: A retrospective observational epidemiological study was conducted to study on-farm reproductive performance (egg production, fertility and hatchability) on 4 ostrich farms in Botswana. An average of 600 birds per farm and a total of 38,447 eggs were involved. The period of operation of the farms ranged from 2-11 years. Fertility ranged from 63.5-89% (μ = 76.3%), while, hatchability ranged from 39.4-83.6% (μ = 53.8%). Hatchability averaged 54.2 and 52.4% and on farms employing the male: female breeding ratio of 1: 2 and 1: 3, respectively, while, it averaged 62.9 and 65.9% on farms employing natural and artificial incubation, respectively. Egg production, fertility and hatchability were all competitive when compared to other country figures although there is still vast room for improvement. Record keeping needs to be encouraged on farms.

Key words: Egg production, fertility and hatchability, Botswana

INTRODUCTION

Ostrich (*Struthio camelus*) farming in Botswana is not well developed despite Botswana being home to the largest wild ostrich population (Mushi *et al*., 2008, OPCSDD, 2005). It lags behind South Africa, Zimbabwe and Namibia in Africa and contributes a paltry 0.2% of the world domesticated flock (OPCSDD, 2005). The large wild population underpins the potential that the Botswana ostrich industry has, since it presents every suggestion that environmental conditions are conducive for ostrich survival. The dearth of information pertaining to reproductive performance of ostriches (Mushi *et al*., 1999; Mushi *et al*., 2008) could be one of the factors hampering growth of the industry. For all farmed species, information derived from on-farm data helps in establishing real targets for performance on a farm or regional basis, highlights losses that occur on individual farms, provides an impartial assessment of stock intended for purchase or culling and enables an objective comparison to be made between individual animals and between farms (Dohoo and Ruegg, 1993; Tranter and Morris, 1990). Realistic targets would in turn provide industries with objective standards. Several measures of productivity for farmed ostriches have been proposed and include the number of eggs laid per hen per year, the percentage of incubated eggs that are fertile (fertility), the percentage of fertile eggs that hatch (hatchability) and the percentage of hatched chicks that survive to a specified age (survival percentage) (More, 1996). Fertility and hatchability rates have been published and range from 10-60 and 27-67%, respectively in countries like Australia, South Africa, Namibia and Zimbabwe (Dzama *et al*., 1995; Deeming, 1996; More, 1996; Cloete *et al*., 1998; Van Schalkwyk *et al*., 2000; Mushi *et al*., 2008). However, such data exists for only one farm in Botswana, involving one breeding season. As a result, farmers are left with no option but to import production targets despite the obvious influences that may be associated with different environmental factors among others. The aim of this study was therefore to conduct an observational epidemiological study involving multiple farms and seasons, on reproductive performance of farmed ostriches in Botswana.

MATERIALS AND METHODS

Egg production records from farms around Botswana were perused for data related to egg production, fertility and hatchability. The farms were basically radiated around Gaborone (24°38' 47S and 25°54' 43E) and Lobatse (25°13'E and 25°55'S), which are 1 014 and 1192 m above sea level, respectively, have a semi-arid climate and receive an annual rainfall of 500 mm. All the farms generally followed similar husbandry systems as described by Mushi *et al.* (2008) including the feed and feeding regime.

Average eggs per hen were computed as:

$$\frac{\text{Total number of eggs laid in a season}}{\text{Number of hens involved}}$$

Fertility was computed as:

$$\frac{\text{Total number of fertile eggs}}{\text{Total number of eggs laid}} \times 100$$

Hatchability was computed as:

$$\frac{\text{Total number of eggs that hatched successfully}}{\text{Total number of fertile eggs set}} \times 100$$

Fertility and hatchability were further analyzed relative to the type of incubation and breeding ratios used, that is, finding averages on the basis of type of incubation and breeding ratios used. Farms visits and interviews with farm managers were also used to augment data collection and for the elaboration of farm procedures.

RESULTS

A total of 4 farms were involved and these were basically those that kept proper records. The period of operation of the farms that participated ranged from 2-11 years. All the farms generally followed the same husbandry patterns and differed mainly in the following ways: some were using artificial incubation while others were using natural incubation and others were using male: female breeding ratios of 1:2 and 1:3 respectively. For purposes of this study, the four participating farms were randomly coded as farms 1-4. Farms 2 and 3 were using natural incubation while farms 1 and 4 were using artificial incubation. The decision to use natural incubation was based on financial considerations. Farms 1, 2 and 4 were also using the male: female breeding ratio of 1: 2, while Farm 3 was using the 1: 3 ratio. Only farms 1 and 4 kept records that depicted fertility. These also happened to be the larger farms that were utilizing artificial incubation. Farm 1 was the longest operating farm and provided records that dated back to 1995, while, other farms provided records that only covered the 2004-2006 period. The number of birds per farm ranged from 67-1953, with an average of 600 birds per farm. Of these, 7% were breeders while the remainder were growers. The breeders' ages ranged from 4-9 years, with an average age of 6 years. The breeders were all fed the same feeds; maintenance ration during off season and breeder ration during breeding seasons.

A total of 38,447 eggs were laid during the period under study, 1.6% of which were from the smaller farms utilizing natural incubation. The average number of eggs laid per hen was 43.2. The fertility of eggs from farms 1 and 4 ranged from 63.5-89% (u = 76.3%) (Fig. 1).

The other causes of egg losses apart from infertility were eggs with holes, cracked eggs, chalky eggs, very small eggs and spoilt eggs.

Overall hatchability ranged from 39.4-83.6% (u = 53.8%) while, mean hatchability rates were 65.9 and 62.9%, at farms using artificial and natural incubation, respectively (Fig. 2).

Average hatchability was slightly higher among farms using the 1: 2 breeding ratio (54.2%) than at the farm that was using the 1: 3 breeding ratio (52.4%) (Fig. 3). The main causes of reduced hatchability included early embryonic death, egg rots, broken yolk, dead-in-shell and weak hatch.

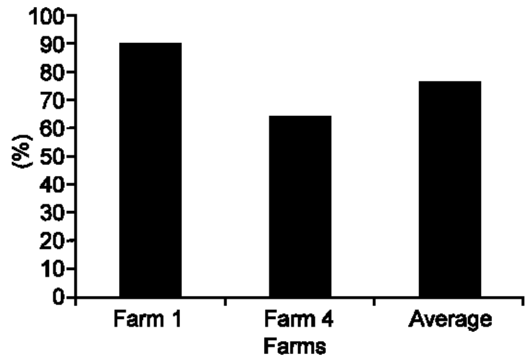


Fig. 1: Egg fertility on farms that had fertility records

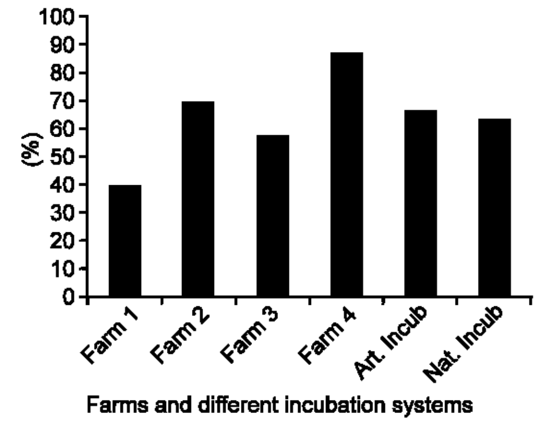


Fig. 2: Hatchability rates among different farms and incubation systems. Key- Art. Incub= artificial incubation farms, Nat. incub = natural incubation farms

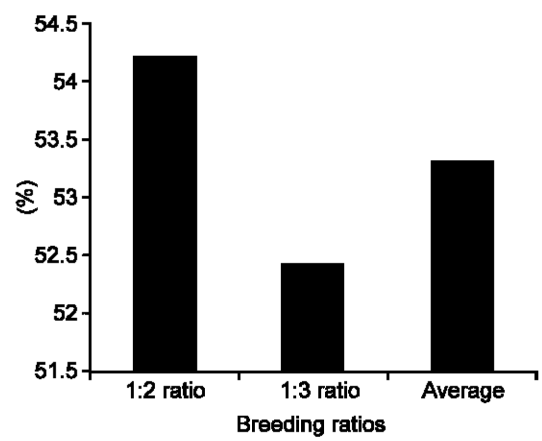


Fig. 3: Hatchability rates at farms using different breeding ratios

Fertility and hatchability over the 7 breeding seasons for Farm 1 showed seasonal variations, but the two were independent of each other (Fig. 4).

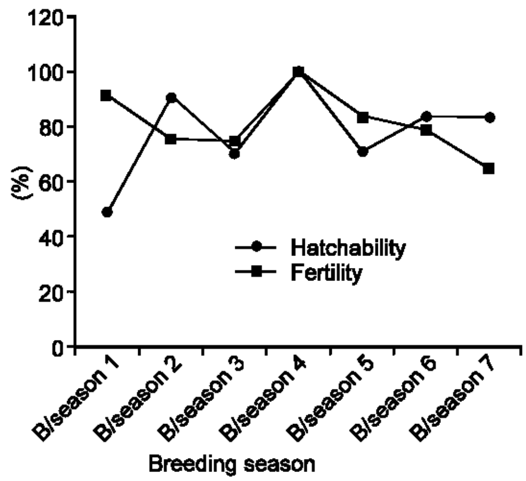


Fig. 4: Fertility and hatchability rates for Farm 1 over 7 breeding seasons to 2005

DISCUSSION

The low participation rate among the farms was attributable to a lack of proper record keeping systems on some farms. This situation is largely worrisome as it deprives the farmers of objective means on which to base important decisions such as culling and economic performance of the enterprises. Egg production at 43.2 eggs/hen/season was at the lower end of the expected 40-60 eggs range. Egg production may be affected by season and breeder age (Ipek and Sahan, 2004). Higher figures are achievable considering that during the recommended 6 months breeding season, a hen producing an egg every other day may produce up to 90 eggs. The mean fertility rate in this study was 76.3% and falls with in the upper range of the 37-90% range published elsewhere (Deeming, 1995; Dzama *et al.*, 1995; Van Schalkwyk *et al.*, 2000; Park *et al.*, 2001). However, this still falls far short of the achievable fertility of >90% noted by Deeming (1996). Fertility was farm related. Eggs are deemed to be infertile, when candling results at days 7-10 of incubation show an apparent lack of embryonic development (Ley *et al.*, 1986). Infertility has been associated with various factors that include young or old age of breeders, diseases, mating problems (behaviour, incompatibilities and efficiency), low or too high nutritional levels, stage of breeding season, shipping stress and inbreeding among others (Black, 1995; Deeming, 1995; Dzama *et al.*, 1995; Van Schalkwyk *et al.*, 2000; Park *et al.*, 2001; Ipek and Sahan, 2004). Seasonal infertility may occur when hens produce eggs early in the season before cocks are able to produce functional spermatozoa, while hormonal imbalances involving testosterone or Follicular Stimulating Hormone (FSH) levels in cocks may also interfere with spermatozoa production (Degen *et al.*, 1994; Black, 1995; Rozenboim *et al.*, 2003). The development of technologies like semen collection and Artificial Insemination (AI) in the ostrich (Rozenboim *et al.*, 2003; Rybnik *et al.*, 2007; Malecki and Rybnik, 2008) may offer more opportunities for the industry as this may allow Breeding Soundness Examinations (BSE) and AI as in other livestock species. In this study, only factors like nutrition and age of breeders could be investigated and were generally similar and therefore unlikely to be the sources of variation. The observation that farms 1 and 4 that were using the same male: female breeding ratio of 1: 2 produced different fertility rates of 63.5 and 89% respectively seems to suggest a lack or low association between fertility and breeding ratios. This could be in agreement with Malecki and Martin (2003), who noted that fertility was not affected by sex ratio. Further more, the existence of sperm-storage tubules at the utero-vaginal junction of the oviduct of the female ostrich (Bezuidenhout *et al.*, 1995; Madekurozwa, 2002) and the fact that ostrich hens can have a fertile period of 5-28 days post-coitus (Birkhead, 1988; Swan and Sicouri, 1999; Malecki *et al.*, 2004) may reduce the need for frequent matings. Also, Malecki *et al.* (2004) noted that fertilisation rate in ostrich eggs is high because most eggs contain excessive numbers of sperm yet very low numbers of sperm appear sufficient to achieve fertilisation.

Hatchability ranged from 39.4-83.6% (u = 53.8%), thus, competing well with the 27-67.5% range noted elsewhere (Deeming, 1996; More, 1996; Bradley, 1997; Mushi *et al.*, 2008). Just like fertility, hatchability was also farm related, with Farm 1 recording high fertility and low hatchability, while Farm 4 had the opposite trend. The causes of poor hatchability in this study were similar to those noted by Mushi *et al.* (2008) and included early embryonic death, egg rots, broken yolk, dead-in-shell chicks and weak hatches. Problems associated with poor hatchability include prolonged pre-incubation storage of 2 weeks, season, poor breeder nutrition, breeder age, improper egg handling that may affect the developing embryo, contamination, incubator or hatcher malfunctions and humidity or temperature problems (Deeming, 1995; Van Schalkwyk *et al.*, 2000; Nahm, 2001; Cabassi *et al.*, 2004; Hassan *et al.*, 2004; Ipek and Sahan, 2004; Malecki *et al.*, 2005). Among these factors only breeder nutrition and age were verifiable and were unlikely to be the sources of variation.

In this study, hatchability rates between farms using artificial and natural incubation did not differ much at 65.9 and 62.9%, respectively. In theory, natural incubation would be expected to yield better results as it has evolved over many years. However, allowing natural incubation diminishes egg production since, the hen would start brooding after laying a clutch, even before the end of the breeding season (Kimwele and Graves, 2003). As a result, workers have been trying to simulate conditions in the natural nest in order to improve on artificial incubation.

Average hatchability also differed slightly among farms using the male: female breeding ratios of 1: 2 and 1: 3 at 54.2 and 52.4%, respectively, probably suggesting a low association between breeding ratio and hatchability. As already noted, hatchability is mainly influenced by incubation circumstances and conditions.

Conclusion: Reproductive performance of ostriches on some Botswana farms compares well with performances noted elsewhere. More effort is however still needed in order to attain optimal results. Breeding ratios did not appear to have an influence on fertility, neither did the mode of incubation on hatchability. Further research is needed on the influence of both factors on ostrich reproduction. Record keeping needs to be encouraged on the farms.

ACKNOWLEDGEMENT

We are grateful to ostrich farmers/managers who allowed us unconditional access to their records.

REFERENCES

Badley, A.R., 1997. Fertility, hatchability and incubation of ostrich (Struthio camelus) eggs. Poult. Avian Biol. Rev., 8: 53-76.

Bezuidenhout, A.J., J.T., Soley, H.B., Groenewald and W.P. Burger, 1995. Sperm-storage tubules in the vagina of the ostrich (Struthio camelus). Onderstepoort J. Vet. Res., 62: 193-199.

Birkhead, T.R., 1988. Behavioural aspects of sperm competition in birds. Advanced Study of Behaviour, 18: 35-72.

Black, D., 1995. Trouble-shooting reproductive problems. In: Ostrich Odyssey 95, Proc. 5th Aust. Ostrich Assoc. Conf., pp: 99-104.

Cabassi, C.S., S. Taddei, G. Predari, G. Galvani, F. Ghidini, E. Schiano and S. Cavirani, 2004. Bacteriologic Findings in Ostrich (*Struthio camelus*) Eggs from Farms with Reproductive Failures. Avian Diseases, 48: 716-722.

Cloete, S.W., H. Lambrechts, K. Punt and Z., 2001. Factors related to high levels of ostrich chick mortality from hatching to 90 days of age in an intensive rearing system. J. South Afr. Vet. Assoc., 72: 197-202.

Deeming, D.C., 1995. Factors affecting hatchability during commercial incubation of ostrich (*Struthio camelus*) eggs. Br. Poult. Sci., 36: 51-65.

Deeming, D.C., 1996. Production, fertility and hatchability of ostrich (*Struthio camelus*) eggs on a farm in the United Kingdom. Anim. Sci., 63: 329-336.

Degen, A.A., S. Weil, A. Rosenstrauch, M. Kam and A. Dawson, 1994. Seasonal plasma levels of luteinizing and steroid hormones in male and female domestic ostriches (*Struthio camelus*). General and Comparative Endocrinol., 93: 21-27.

Dohoo, I.R. and P.L. Ruegg, 1993. Herd level measures of health and productivity in Prince Edward Island dairy herds. Preventative Vet. Med., 16: 241-254.

Dzama, K., F. Mungate and J.H. Topps, 1995. Ostrich production in Zimbabwe: summary of survey results. J. Applied Sci. in S. Africa, 1: 142-146.

Hassan, S.M., A.A. Siam, M.F. Mady and A.L. Cartwright, 2004. Incubation temperature for ostrich (*Struthio camelus*) eggs. Poult. Sci., 83: 495.

Ipek, and Sahan, 2004. Effect of breeder age and breeding season on egg production and incubation in farmed ostriches. Br. Poult. Sci., 45: 643-647.

Kimwele, C.N. and J.A. Graves, 2003. A molecular genetic analysis of the communal nesting of the ostrich (*Struthio camelus*). Molecular Ecol., 12: 229-236.

Ley, D.H., R.E. Morris, J.E. Smallwood and M.R. Loomis, 1986. Mortality of chicks and decreased fertility and hatchability of eggs from a captive breeding pair of ostriches. J. Am. Vet. Med. Assoc., 189: 1124-1126.

Madekurozwa, M.C., 2002. Progesterone and oestrogen receptor immunoreactivity in the vagina of the immature ostrich, Struthio camelus. Br. Poult. Sci., 43: 450-456.

Malecki, I.A. and G.B. Martin, 2003. Sperm supply and egg fertilization in the ostrich (*Struthio camelus*). Reprod. Domestic Anim., 38: 429-435.

Malecki, I.A., S.W.P. Cloete, W.D. Gertenbach and G.B. Martin, 2004. Sperm storage and duration of fertility in female ostriches (*Struthio camelus*). South Afr. J. Anim. Sci., 34: 158-165.

Malecki, I.A., J.O. Horbanczuk, C.E. Reed, G.B. Martin, 2005. The ostrich (*Struthio camelus*) blastoderm and embryo development following storage of eggs at various temperatures. Br. Poult. Sci., 46: 652-660.

Malecki, I.A. and P.K. Rybnik, 2008. Artificial insemination of female ostriches using voluntary crouch. Aust. J. Exp. Agric., 48, xix-xix (1 page paper presented at the 4th International Ratite Science Symposium with XXIII World's Poultry Congress, 29 June-4 July 2008, Brisbane, Australia.

More, S.J., 1996. The performance of farmed ostrich eggs in eastern Australia. Preventative Vet. Med., 29: 91-106.

Mushi, E.Z., J.F.W. Isa, R.G. Chabo, L. Modisa and P. Kono, 1999. Commercial ostrich farming in Botswana. S. Afr. J. Anim. Sci., 29 (3).

Mushi, E.Z., M.J. Binta, R.G. Chabo and O. Galetshipe, 2008. Problems associated with artificial incubation and hatching of ostrich (*Struthio camelus*) eggs in Botswana. Res. J. Poult. Sci., 2: 21-26.

Nahm, K.H., 2001. Effects of storage length and weight loss during incubation on the hatchability of ostrich eggs (*Struthio camelus*). Poult. Sci., 80: 1667-1670.

Ostrich Products Case Study Discussion Draft, 2005. The potential for export diversification in Botswana.

Park, S.Y., H.M. lee, K. Matsuda and C.W. Lim, 2001. Observation of the incubation of imported ostrich (*Struthio camelus)* eggs in a farm. Korean Vet. J., 24: 369-374.

Rozenboim, I., A. Navot, N. Snapir, A. Rosenstrauch, M.E. El Halawani, G. Gvaryahu and A. Degen, 2003. Method for collecting semen from the ostrich (*Struthio camelus*) and some of its quantitative and qualitative characteristics. Br. Poult. Sci., 44: 607-611.

Rybnik, P.K., J.O. Horbanczuk, H. Naranowicz, E. Lukaszewicz and I.A. Malecki, 2007. Semen collection in the ostrich (*Struthio camelus*) using a dummy or a teaser female. Br. Poult. Sci., 48: 635-643.

Swan, R.A. and O. Sicouri, 1999. Evidence of sperm storage in the female ostrich. Aust. Vet. J., 77: 649-650.

Tranter, W.P. and R.S. Morris, 1990. The epidemiological approach to herd problem- solving. In Epidemiology at work. University of Sydney Post Graduate Committee in Veterinary Science, 1990; Proceedings No., 144: 161-174.

Van Schalkwyk, S.J., S.W. Cloete, C.R. Brown and Z. Brand, 2000. Hatching success of ostrich eggs in relation to setting, turning and angle of rotation. Br. Poult. Sci., 41: 46-52.