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Hatching success and chick mortality of the ostrich (*Struthio camelus*) in a commercial farm in Nepal

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Abstract

Commercial ostrich farming for trading meat and feathers is relatively new in Nepal. This study investigated hatching success and chick mortality rates in the only commercial ostrich farm in Nepal- Ostrich Nepal Pvt. Ltd, Rupandehi, Lumbini Province, Nepal. The number of eggs laid, hatched and their mortality were observed from 2014 to 2020. Results revealed higher embryonic deaths than hatching percentage, however, chick's mortality rate was comparatively lesser. Breeding population required more nutritional diet to ensure fertile eggs. Hatchability was affected by temperature, humidity and turning of eggs. Microbial contamination and infertility were the major contributors for embryonic death. Intense care is required for the young chicks as they are very vulnerable to heat, rain and infections. Nutrition, and proper temperature and humidity management are major aspects to foster the growth and development as well as to ensure better reproductive ability of ostriches in order to lower mortality and avoid economic loss.

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1. Introduction

Commercial poultry farming is becoming more intensive, geographically concentrated, vertically integrated and linked with global supply chains (FAO, 2021). The poultry industry has taken a quantum leap in the last three decades evolving from a near backyard practice to a venture of industrial promotion (Dhaliwal *et al.*, 2019). Poultry meat contributes a substantial proportion of the total meat production in the world. Introduction of modern intensive production methods, genetic improvements, improved disease preventive and control methods, biosecurity measures, increasing income, expansion of the human population, and urbanization, have contributed to structural changes of poultry industry. An increasing population, greater purchasing power and urbanization have been strong drivers of growth; however, the growth rate of the production is not sufficient to satisfy the per capita meat requirement (FAO, 2021).

The situation is even worse in developing countries where the poultry industry faces numerous challenges including increased cost of production, lack of bio-security measures, improper maintenance of housing, lack of proper knowledge about poultry production, irregular supply of qualifiable chicks, and the outbreak of diseases (Akinola & Essien, 2011; Dhakal *et al.*, 2019).

Besides conventional practices of farming chickens, ducks, turkeys and geese, commercial farming of ostrich has been expanded out of Africa across the world including to developing countries of the South Asia.

Ostrich (*Struthio camelus*) is the largest ratite (flightless bird without a keel bone) having a height of 2.4 - 2.75 m and a weight of approximately 100-150 kg (Brown *et al.*, 1982; Deeming & Angel, 1996). They exhibit sexual dimorphism through feather coloration: black feathers and white tail in male and greyish-brown and white in females

(Davies & Bertram, 2003). Environments include open, short-grass fields within woodlands (Jarvis *et al.*, 1985) and arid /semi-arid regions with green areas (Williams *et al.*, 1993; Verlinden & Masogo 1997). Breeding usually takes place in the dry season when ample of food is required (Magige *et al.*, 2009). Several females share the same nest for laying, as they prefer communal breeding, though only the breeding female and territorial male provide parental care (Franz-Sauer & Sauer, 1966; Kimwele & Graves, 2003).

The primary commercial ostrich cultivate was set up in South Africa around the 1860s solely for gathering feathers which later spread to countries such as Australia, and Egypt (Hastings & Farrell, 1991; van der Vyver, 1992). As the demand for meat and hides increased, it has been developed as an alternative for agriculture throughout the globe with an increase in its global market reach (Deeming & Angel, 1996). Modern farming, mostly dependent upon artificial incubation, still suffers from high mortality of chicks and embryos (Brassó *et al.*, 2020). The genetic and nutritional status as well as mating efficiency determine the fertility (Deeming, 1995; Cooper, 2004). Variables which can influence hatchability amid incubation include temperature, humidity, respiratory gas trade and egg turning, and the contamination of eggs (Deeming, 1995).

Commercial ostrich farming is a blooming business as every part (meat, feathers and hides) of these birds has economic value in the world market as it is a million-dollar industry. South Africa dominates over 50 percent of the world market for ostrich products (Brand & Jordaan, 2011). Ostrich meat has got best nutritional value with a low amount of fat and high polyunsaturated fatty acids, in comparison to other live stock (Cooper & Horbañczuk, 2002; Magige & Roskaft 2017). The ostrich meat market is growing rapidly in the globe because of its health values; however, it is estimated that ostrich farmers are meeting only 10 percent of the consumer demand in the world (Abbas *et al.*, 2017). Poor farm management and low hatchability have hindered the progression of the industry.

In Nepal, commercial ostrich farming is a relatively new industry which was started by Ostrich Nepal Pvt. Ltd, Rupandehi, Lumbini Province in 2008, for meat and feather production. Being new and one of the global market prospects for ostrich products, this study was carried out to generate information on the effectiveness of captive breeding practices and hatchability success of ostriches and to identify the major challenges of ostrich farming in a developing country such as Nepal.

2. Materials and Methods

2.1 Study farm and animals

The study farm, Ostrich Nepal Pvt. Ltd., is located at Gongoliya-22, Tilottama Municipality, Rupandehi district of Lumbini Province, Nepal. This farm was started in 2008, initially with 1500 eggs imported from South Africa. At present, the farm accommodates more than 5500 ostriches including 941 parent breeders within an area of 5.52 hectares. Ostriches in the farm have been kept in six different enclosures measuring from 37×33 meters to 152×122 meters accounting total enclosure area of 48921 square meters. Breeding usually takes place during the months of December and January. They are generally bred in a ratio 1 male:2 females. A female lays an average of 70 to 80 eggs during the breeding season. The protein content of the diet is increased from 24% to 28% during the breeding season. Only eggs of average size (15.7±1.53 cm) that weigh between 1.2 to 2 kg are taken for incubation. Candling is done at regular intervals to ensure that eggs are healthy. Then, the hatched chicks are placed in a brooder where proper care is given to them. Initially, chicks are provided with lesser feed (approx. 1000 gm) until four months of hatching. The feed is increased to about 2.5 kg up to 5 kg per day, comprising 60% percent dry grass or fresh grass with protein diets such as maize, wheat, soya beans, etc. as they mature. A matured ostrich is fed either 2.5 kg dry grass or 4 kg fresh grass per day, mixed with 24% protein diet.

2.2 Data collection and analysis

The number of eggs laid, chicks hatched and their mortality were monitored from 2014 to 2020. Eggs were collected twice a day and their records taken. The eggs in the incubator were candled on a regular basis to remove any infertile or contaminated eggs. Eggs with no dark shadowing and no sign of embryonic development were deemed infertile and those with dark blotches and a rotten smell were taken to be contaminated rather than infertile (Deeming, 1995). Malposition of chicks, fluctuation in physical parameters, breeder's infertility, etc. were thought as the other possible reasons behind embryonic death (Cooper, 2001). The hatchability, embryonic mortality and chick mortality rates were calculated as follows:

$$\text{Hatchability rate (\%)} = \frac{\text{Total number of hatched eggs}}{\text{Total number of eggs taken for trial}} \times 100$$

$$\text{Embryonic mortality rate (\%)} = \frac{\text{Number of unhatched fertile eggs}}{\text{Total number of fertile eggs}} \times 100$$

$$\text{Chicks mortality rate (\%)} = \frac{\text{Number of dead chicks}}{\text{Number of chicks at onset of brooding}} \times 100$$

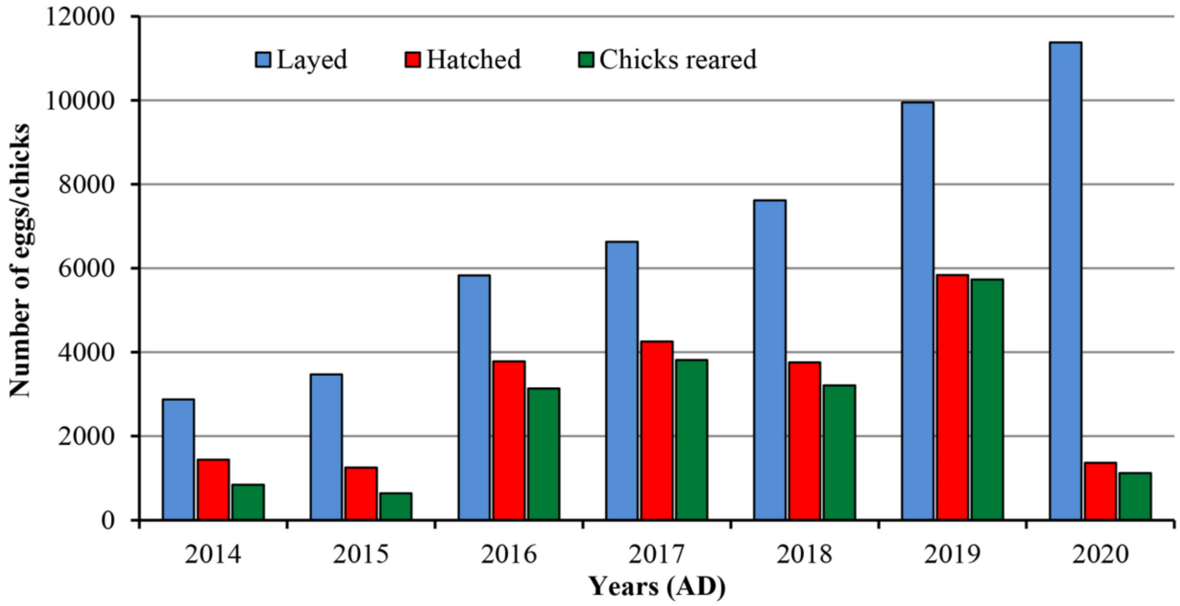

Figure 1. Annual trend in the number of ostrich eggs laid, hatched and chicks reared in the study farm

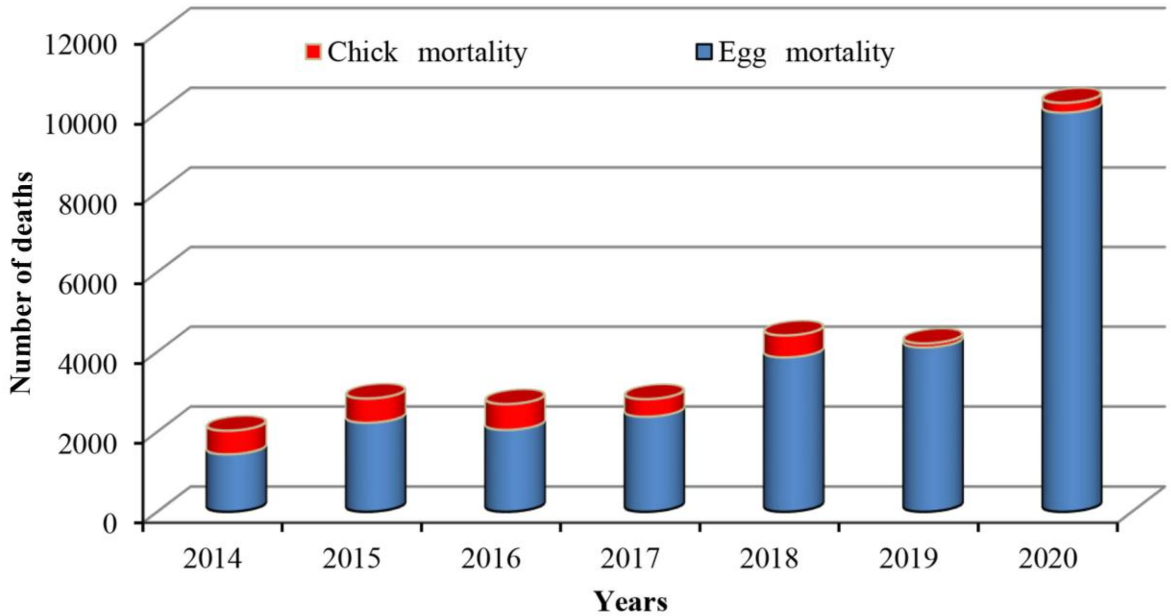

Figure 2. Annual egg and chick mortality of ostrich in the study farm

The significant difference between the number of eggs taken for trial and hatched eggs; and between hatched eggs and chicks reared for each year during the study period (2014–2020 AD) were tested by the paired T-test.

3. Results

3.1 Breeding success of the ostrich

A total of 2,875 eggs were laid in 2014, about half (n=1439) of which were hatched, and 59% of the chicks were reared successfully (Fig.1). The number of eggs laid increased each year to a value of over 11,000 in 2020 as the number of parent breeders also increased simultaneously. The annual number of eggs hatched and chicks reared also showed a similar trend to the laid eggs, reaching a maximum in 2019 (n=6,008). However, the successful hatching and chick rearing drastically decreased to less than 1,400 in 2020. There were significant differences between the number of eggs laid and hatched ($t=3.35$, $df=6$, $p<0.05$) and between the hatched eggs and chicks reared ($t=5.83$, $df=6$, $p<0.05$) among the study years.

3.2 Egg and chick mortality in the ostriches

Egg (embryonic) mortality was higher than chick mortality, the latter being very low in 2019 in comparison to the former. It reached a peak of 9,000 in 2020 (Fig. 2). The hatching rates were not stable, the highest was recorded in 2016, whereas the lowest was in 2020. The year 2020 also recorded the highest mortality rate (Fig. 3).

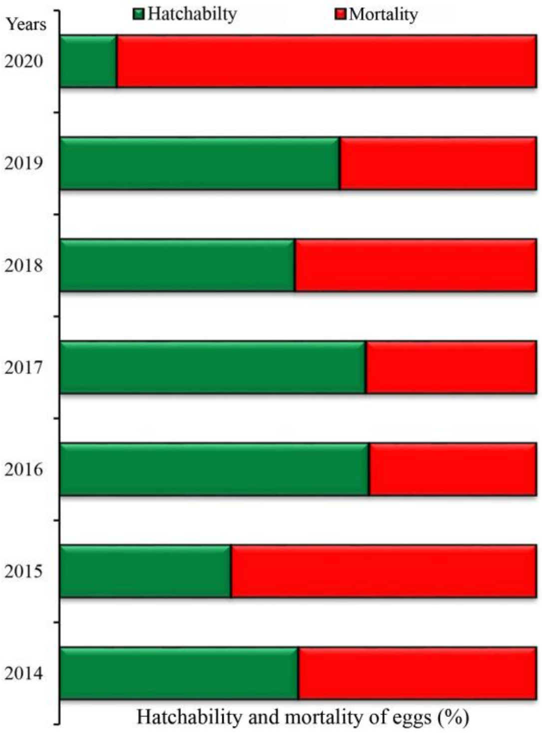

Figure 3. Annual hatchability and mortality of the ostrich eggs in the study farm

Over the study period of seven years, the mortality rate in the farm (54.57%) exceeded the hatching rate (45.42%) (Fig. 4). However, the average chick mortality for the seven years was low (<15%). Microbial contamination was deemed to be the major contributor to the deaths of embryos (49.8%), whereas infertility (30.7%) also contributed to the deaths.

4. Discussion

Ostrich farming is relatively new in Nepal and currently commercial farming is done only in the Ostrich Nepal Pvt. Ltd. in the Lumbini Province. We studied the breeding success as egg hatchability and chick mortality in the farm analyzing data for the seven years from 2014 to 2020. The breeding seasons of the ostrich is known to vary, globally (Deeming, 1996).

In Nepal, ostriches breed during the dry season (Magige *et al.*, 2009). Females with higher productivity can lay up to 80 to 100 eggs in communal nests during the breeding season (Shanawany, 1995). In commercial farming, eggs are collected twice a day to avoid females from incubating, as it halts laying which could cause economic losses (Shanawany, 1995). The farm of this study also collected eggs at least twice often and rarely thrice each day. Breeding ostriches were fed on a more protein diet, as it is known to improve the reproductive ability (Franz Sauer & Sauer, 1966; Wilson, 1997; Magige *et al.*, 2009).

The hatching rates varied among the study years which could have been influenced by a number of factors. Eggs weighing 1.2 to 2 kg were only taken for incubation as the medium-weight eggs are productive and fit in the crates (Abbaspour-Fard *et al.*, 2010). Other parameters such as weight, shell thickness and porosity, shape index, and consistency of the contents also influence the hatchability of the eggs (Narushin & Romanov, 2002). Nearly all the laid eggs in the farm met the ideal values (Narushin & Romanov, 2002; Abbaspour-Fard *et al.*, 2010) with only about one in thousand eggs was discarded in terms of weight. Temperature is known to affect the hatching duration (Cooper, 2001). Temperature in the incubator can range from 35 to 37 ºC while the optimum temperature has to be maintained at 36.4 ºC (Okasha *et al.*, 2019). The optimum temperature 36.4 ºC was maintained throughout the incubation period in the farm except when there was a power cutoff for a long duration. The candling to ensure the health of the eggs (Deeming, 1995) were done on the 15th, 25th and 40th days of incubation. Despite these efforts, hatching success was low in the farm. Among other factors not analyzed in this study, microbial contamination could be one of the major causes of eggs mortality during incubation (Deeming, 1996). Therefore, proper hygiene of the incubator is a must to avoid egg loss (Cooper, 2001). Turning of eggs is critical for successful hatching (Deeming, 2009). Some studies suggest that turning ostrich eggs 24 times per day gives superior results compared with turning eggs only five times per day (Cooper, 2001).

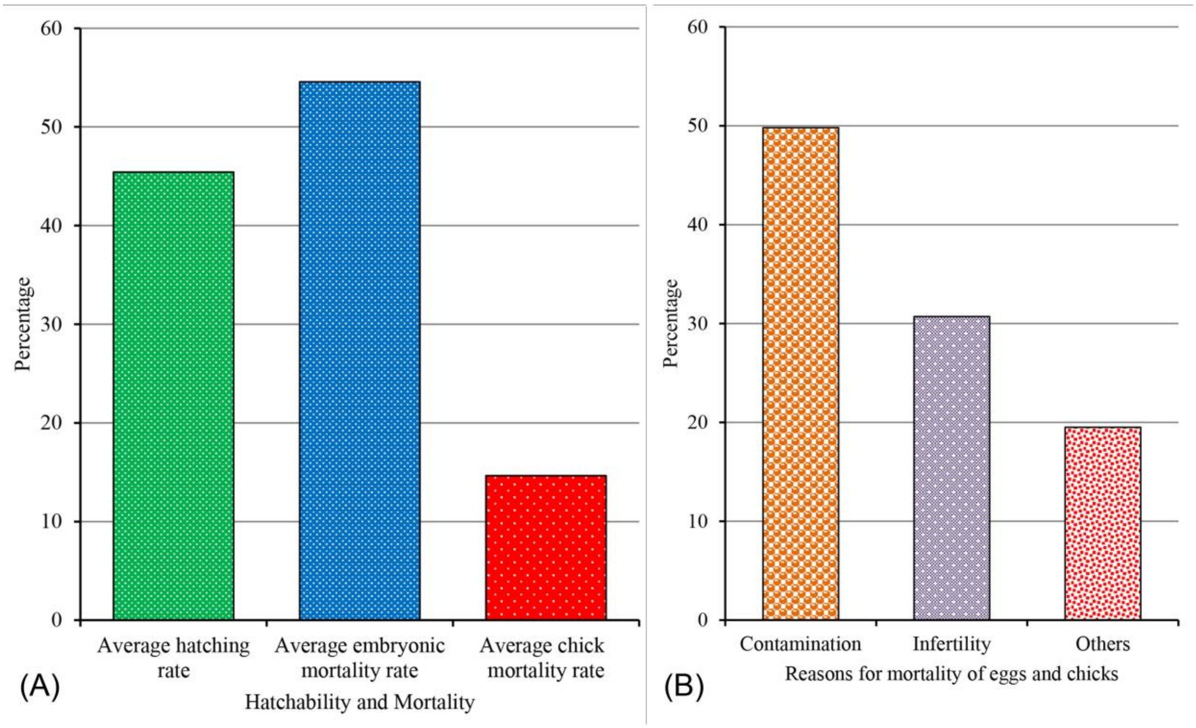

Figure 4. Breeding success and mortality of ostriches in the study farm. A, Average hatching, embryonic mortality and chick mortality rate; B, causes of embryonic death.

Such rotation is believed to enhance the hatchability by promoting the growth of the embryo and preventing the embryo from being attached to the inner shell membrane (Deeming, 1993).

The farm managed autorotation of the eggs at each hour. However, the embryonic mortality was still higher in the study farm than in other studies; for example, Abbaspour-Fard *et al.* (2010) reported 44% embryonic deaths in ostriches under experimental conditions. Most of the embryonic deaths were recorded during the first and last weeks of incubation which was consistent with the findings of other studies (Deeming, 1995; Badley, 1997). The massive rise in embryonic deaths in 2020 was caused by the power failure in the incubator, maintenance of which was delayed due to the lockdown imposed by the government against the COVID-19 pandemic. The inability to maintain optimum temperature (36.4 ºC) within the incubator and continuous rotation of eggs created a considerably high death toll.

The chick mortality was also high in the farm. The young ostrich chicks are very vulnerable up to the age of three months due to multiple reasons (Cloete *et al.*, 2001; Cooper, 2004). Proper nutritional feed is a major aspect for growth and for fostering reproductive abilities. In fact, poor nutrition has been referred to as the primary cause of high chick mortalities (Okasha *et al.*, 2019). As in breeding ostriches, these young broods also need an additional protein diet whilst being protected from high humidity (Cooper, 2000, 2004). Additionally, overcrowding contributes to nutritional stress and disease (Cooper, 2001). The humidity and temperature maintenance are also a critical factor in brooders where temperature was adjusted above 30 ºC (Okasha *et al.*, 2019). Apart from these, chick mortality is also linked to stress, as a result of their inability to adjust to the rearing environment (Cloete *et al.*, 2001). Evaluating the study farm against possible overcrowding revealed that it has a stocking density of 8.9 m^2/individual which is ample space for normal growth and breeding of ostriches (Mahrose *et al.*, 2019). Therefore, maintenance of balanced diet and external factors such as heat and moisture are vital for lowering mortality and in turn to prevent great economic losses in the ostrich farm.

5. Conclusion

Commercial ostrich farming is a new concept in Nepal with the goals of exporting ostrich products worldwide, and establishing a local market. The artificial incubation technique requires utmost care and supervision because embryonic mortality in ostriches is high. Proper management of environmental factors such as temperature, humidity, etc. and a balanced feed supply are critical factors that assure high productivity in ostrich farms so avoiding economic losses.

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Author's Contributions

BA and LK conceptualized the study. BA collected and analyzed the data. BA and LK wrote and finalized the manuscript. LK supervised the work.

Competing Interests

The authors declare that they have no competing interests.

References

Abbas, G., Mahmood, S., Sajid, M., Ali, Y. (2017) Ostrich farming: A new turn in poultry industry of Pakistan, *Advances in Zoology and Botany* **5 (3)**:33–38. https://doi.org/10.13189/azb.2017.050302

Abbaspour-Fard, M.H., Emadi, B, Aghkhani, M.H. (2010) Fertility recognition of ostrich eggs using physical properties, *Journal of Applied Sciences* **10 (14)**: 1405–1412.

Akinola, L.A.F., Essien A. (2011) Relevance of rural poultry production in developing countries with special reference to Africa, *World's Poultry Science Journal* **67 (4)**: 697–705. https://doi.org/10.1017/S0043933911000778

Badley, A.R. 1997. Fertility, hatchability and incubation of ostrich (*Struthio camelus*) eggs, *Poultry Avian Biology Review* **8**: 53–76.

Brand, T.S., Jordaan, J.W. (2011) The contribution of the South African ostrich industry to the national economy, *Appled Animal Husbandry and Rural Development* **4**: 1–7.

Brassó, D.L., Béri, B., Komlósi, I. (2020) Studies on ostrich (*Struthio camelus*), *Acta Agraria Debreceniensis* 15–22. https://doi.org/10.34101/actaagrar/1/3772

Brown, L., Urban, E., Newman, K. (1982) Order Struthioniformes. In: *The Birds of Africa*, Volume 1, pp. 32–37, Academic Press, New York.

Cloete, S., Lambrechts, H., Punt, K., Brand, Z. (2001) Factors related to high levels of ostrich chick mortality from hatching to 90 days of age in an intensive rearing system, *Journal of the South African Veterinary Association* **72**: 197–202. https:// doi.org/10.4102/jsava.v72i4.652

Cooper, R.G. (2000) Critical factors in ostrich (*Struthio camelus australis*) production: a focus on southern Africa, *World's Poultry Science Journal*.**56**:247–265. https://doi.org/10.1079/WPS20000019

Cooper, R.G. (2001) Handling, incubation, and hatchability of ostrich (*Struthio camelus var. domesticus*) eggs: a review, *Journal of Applied Poultry Research* **10**: 262–273. https://doi.org/10.1093/japr/10.3.262

Cooper, R.G. (2004) Ostrich (*Struthio camelus*) chick and grower nutrition, *Animal Science Journal* **75**: 487–490. https://doi.org/10.1111/J.1740-929.2004.00217.x

Cooper, R.G., Horbañczuk, J.O. (2002) Anatomical and physiological characteristics of ostrich (*Struthio camelus var. domesticus*) meat determine its nutritional importance for man, *Animal Science Journal* **73**: 167–173. https://doi.org/10.1046/j.1344-941.2002.00024.x

Davies, S.J.J.F., Bertram, B.C.R. (2003) Ostrich. In: Perrins, Christopher (ed.), Firefly Encyclopedia of Birds, pp. 34–37. Buffalo, NY: Firefly Books, Ltd.

Deeming, D. (1995) Factors affecting hatchability during commercial incubation of ostrich (*Struthio camelus*) eggs, *British Poultry Science* **36**: 51–65. https://doi.org/10.1080/00071669508417752

Deeming, D. (1995) The hatching sequence of ostrich (*Struthio camelus*) embryos with notes on development as observed by candling, *British Poultry Science* **36**: 67–78. https://doi.org/10.1080/00071669508417753

Deeming, D. (1996) Production, fertility and hatchability of ostrich (*Struthio camelus*) eggs on a farm in the United Kingdom, *Animal Science* **63**:329–336. https://doi.org/10.1017/S1357729800014880

Deeming, D., Angel, C. (1996). Introduction to the ratites and farming operations around the world. Improving our understanding of ratites in a farming environment, *Proceeding of the Ratite Conference*, Oxfordshire, UK, pp 1–4.

Deeming, D.C. (2009) The role of egg turning during incubation, *Avian Biology Research* **2**: 67–71. https://doi.org/10.3184/175815509X431849

Dhakal, R., Joshi, B., Karn, R., Bhusal, S., Acharya, B. (2019) A review on scenario, challenges and prospects of poultry production in Nepal, *Malaysian Journal of Sustainable Agriculture* **3 (2)**:60–63. http://doi.org/10.26480/mjsa.02.2019.60.63

Dhaliwal, A.P.S., Shelly, M., Grover J. (2019) Role of poultry farming for socio-economic development of Punjab farmers. Poultry Punch (English Monthly Magazine). Accessed from https://thepoultrypunch.com/2019/10/role-of-poultry-farming-for-socio-economic-development-of-punjab-farmers/

FAO (2021) Gateway to poultry production and products. In- Food and Agriculture Organization of the United Nations. Accessed from http://www.fao.org/poultry-production-products/socio-economic-aspects/poultry-chain/en/

Franz-Sauer, E., Sauer, E.M. (1966) Social behaviour of the South African ostrich, *Struthio camelus australis*, *Ostrich* **37**: 183–191. https://doi.org/10.1080/00306525.1966.9639797

Hastings, M.Y., Farrell, D.J. (1991) A history of ostrich farming—Its potential in Australian agriculture. Pages 292–297 In: Recent Advances in Animal Nutrition Australia. University of North England, Armidale, Australia. Accessed from- http://livestocklibrary.com.au/handle/1234/19657

Jarvis, M., Jarvis, C., Keffen, R. (1985) Breeding seasons and laying patterns of the southern African ostrich *Struthio camelus*, *Ibis* **127**: 442–449. https://doi.org/10.1111/j.1474-919X.1985.tb04840.x

Kimwele, C., Graves, J. (2003) A molecular genetic analysis of the communal nesting of the ostrich (*Struthio camelus*), *Molecular Ecology* **12**: 229–236. https://doi.org/10.1046/j.1365-294x.2003.01727.x

Magige, F., Røskaft, E. (2017). Medicinal and commercial uses of ostrich products in Tanzania, *Journal of Ethnobiology and Ethnomedicine* **13**: 48. https://doi.org/10.1186/s13002-017-0176-5

Magige, F. J., Stokke, B. G., Sortland, R., Røskaft, E. (2009) Breeding biology of ostriches (*Struthio camelus*) in the Serengeti ecosystem, Tanzania, *African Journal of Ecology* **47**: 400–408. https://doi.org/10.1111/j.1365-2028.2008.01002.x

Mahrose, K.M., Abdel-hack, M., Amer, S.A. (2019) Influences of dietary crude protein and stocking density on growth performance and body measurements of ostrich chicks, *Annals of the Brazilian Academy of Sciences* **91**: e20180479. https://doi.org/10.1590/0001-3765201920180479

Narushin, V.G., Romanov, M.N. (2002) Egg physical characteristics and hatchability, *World's Poultry Science Journal* **58 (3)**: 297–303. https://doi.org/10.1079/WPS20020023

Okasha, M.A., Attia, A., Mahrose, K. (2019) Ostrich breeding in China, *Zagazig Journal of Agricultural Research* **46**: 1583–1591. https://doi.org/10.21608/zjar.2019.48177

Shanawany, M.M. (1995) Recent developments in ostrich farming, *World Animal Review* **83**: 3–8. Accessed from- http://www.fao.org/3/v6200t/v6200T02.htm

van der Vyver, A. (1992) The world ostrich industry: Will South Africa maintain its domination? *Agrekon* **31**: 47–49. https://doi.org/10.1080/03031853.1992.9524268

Verlinden, A., Masogo, R. (1997) Satellite remote sensing of habitat suitability for ungulates and ostrich in the Kalahari of Botswana, *Journal of Arid Environment* **35**: 563–574. https://doi.org/10.1006/jare.1996.0174

Williams, J.B., Siegfried, W.R., Milton, S.J., Adams, N.J., Dean, W., du Plessis, M.A., Jackson, S. (1993) Field metabolism, water requirements, and foraging behavior of wild ostriches in the Namiba, *Ecology* **74**: 390–404. https://doi.org/10.2307/1939301

Wilson, H.R. (1997) Effects of maternal nutrition on hatchability, *Poultry Science Journal* **76 (1)**: 134–143. https://doi.org/10.1093/ps/76.1.134