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Breeding Ecology and Nesting of the Laughing Dove (*Spilopelia Senegalensis*) in District Dera Ismail Khan, KPK, Pakistan

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Abstract

The Laughing Dove (*Spilopelia senegalensis*) is a widely distributed columbid species whose breeding ecology remains insufficiently studied in many parts of South Asia. The present study was conducted in District Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan, to investigate the breeding ecology, modification patterns, and factors influencing reproductive success of the species. Fieldwork was carried out during the 2024 breeding season, and a total of 87 nests were examined across different habitats. Data were collected on nest position, height, tree species preference, clutch size, hatching and fledging success, and causes of breeding failure. The results indicated that Laughing Doves preferred nesting in the middle portions of trees (44.82%), followed by forks (35.63%) and terminal branches (19.54%). The majority of nests were constructed at moderate heights between 3.1–4.0 m, particularly on Quercus incana (31.03%) and Olea ferruginea (16.09%). The mean clutch size was 2.0 eggs per nest, of which 67.74% hatched and only 20.68% successfully fledged. Predation (12.90% of eggs; 24.13% of nestlings), hunting (19.35% of eggs; 36.78% of nestlings), and accidental nestling falls (18.39%) were identified as the major causes of breeding failure. These findings demonstrate that while Laughing Doves exhibit ecological adaptability in nest site selection and vegetation use, their breeding success is constrained by natural predation and human disturbance. The study contributes new baseline information on the species' ecology in Pakistan and highlights the importance of habitat protection, hunting control, and community involvement in avifaunal conservation. Long-term monitoring and comparative studies with other Columbidae species are recommended to strengthen understanding of breeding dynamics under changing ecological conditions.

Keywords: Laughing Dove, breeding ecology, nest site selection, clutch size, breeding success, predation, Pakistan.

Introduction

Vertebrates are divided into five different groups: mammals, birds, amphibians, reptiles and fish.(Bhuvaneswari & Dhulipala, 2013). Birds belong to class Aves with various sizes and morphology, that are distributed worldwide but some bird species are endemic to particular regions of the world and habitats.They range in body size from 2 (inches) that is hummingbird (Mellisuga helenae) to the 118 (inches) ostrich (Cooper et al., 2009)'Ave's is the major group or class of birds which comprises the subdivision Palaeognathae (group of flightless birds), the tiramisu (birds with weak flight), and the Neognathae (flight birds) (Platt et al., 2021). Birds are believed to have evolved from theropod dinosaurs during the Jurassic period, with fossil evidence supporting their emergence as a separate lineage around 150 million years ago. (Chiappe & Witmer, 2002).Birds are egg-laying warm-blooded vertebrates belonging to the class Aves that have bills, two wings, and the whole body is covered by feathers.(Govender, 2021).The reflective system of birds like skeletal, digestive, and respiratory systems has been gifted with creations suited for flight. Further water birds have some structures to swim. (Yonezawa et al., 2017). Birds are the integral components of terrestrial and aquatic ecosystem s, play vital roles in ecological balance through pollination, seed dispersal, and pest control (Bibby, 2000) .They are pollution-sensitive indicators. Birds devour large numbers of harmful insects, as well as their larvae and eggs, hence serve as biological control agents keeping insect pests populations in check thus being good friends of farmers.(Binkowski et al., 2019).

Birds fulfill many ecological functions in their habitats. For instance, they are bioindicators of healthy ecosystems (Mistry et al., 2008) In addition, insectivorous species and raptors regulate disease vectors, including mosquitoes and rodents. Scavenger birds, such as the pied crow (Corvus albus), contribute to biomass recycling and to some degree reduce levels of disposable wastes. Frugivorous birds play an important role in seed dispersal of fleshy fruit-producing plants.(Stevenson & Fanshawe, 2020).They are social, they communicate using visual signals and through calls and songs and participate in social behaviors including cooperative breeding, hunting, floating, and mobbing of predators. Many species are of economic importance, mostly a source of food acquired through hunting or farming. Some species particularly songbirds and parrots are popular as pets. (Roberts, 1992).

Birds are one of the most popular life forms on the planet, and its diversity leads to a richness of life and beauty. There are around 9000 species of birds living in the world today, with a tremendous diversity of life style (Dad et al., 2014). The global population sizes of species vary by many orders of magnitude. Among the birds, the rarest presently numbers just a handful of wild individuals (Bird Life, 2000), whilst the most abundant has many hundreds of millions. Numerous reasons can be suggested for these differences, including the influences of body size, life history, trophic group, phylogeny and history (Blackburn & Gaston, 2001). As regards birds, the total number of birds species in the world today is 9040 and the total number of taxa of birds of Indo-Pakistan sub-continent is 2060.(Ali & Ripley, 1983) The variety of avian species in ecosystems reflects the well-being of its habitat. Birds are the indicators of environment and are being used for conservation and environmental impact assessment (Gregory et al., 2003).As bird's richness and diversity are the most prevalent lives, which lead beauty to the existing life on the earth. Apart from this, their essentially beautiful plumage, melodious songs, always have fascinated mankind .(Roberts, 1992).At present, worldwide there are about 9040 bird species. Fortunately, Pakistan has all possible ecosystems that support rich diversity of bird species (Khan & Gabol, 2023).

Birds play an important role in ecosystems as seed dispersers, pollinators, and indicators of environmental health. Despite the ecological importance of avifauna, many bird species face pressures from habitat loss, predation, hunting, and human disturbance. The Laughing Dove (*Spilopelia senegalensis*) is one of the most widely distributed columbid species in Asia and Africa, yet information on its breeding ecology remains limited, particularly in Pakistan. Although some studies have been conducted in other regions such as India, North Africa, and the Middle East, very little is known about its nest site selection, clutch size, nesting success, and breeding failures in the semi-arid landscapes of Khyber Pakhtunkhwa. In District Dera Ismail Khan, agricultural expansion, tree cutting, and hunting are common threats that may significantly affect the reproductive success of Laughing Doves. However, scientific data documenting these impacts are scarce. This gap in knowledge hinders the ability of researchers and conservation planners to develop effective strategies for the protection of this species and its habitat. Therefore, the problem addressed in this research is the lack of baseline information on the breeding ecology and nidification of Laughing Doves in this region, which is necessary for understanding their population dynamics and ensuring long-term conservation.

The overall aim of this study was to investigate the breeding ecology, nidification patterns, and reproductive success of the Laughing Dove (*Spilopelia senegalensis*) in District Dera Ismail Khan, Pakistan. This study is significant because it provides the first detailed account of the breeding ecology and nidification of the Laughing Dove in District Dera Ismail Khan. By filling a gap in the existing literature, the findings contribute to the global understanding of Columbidae reproductive biology and highlight the challenges faced by this species in semi-arid ecosystems. The research is also valuable for conservation biologists, as it identifies specific threats such as predation, hunting, and habitat disturbance, which can be addressed through management interventions.

The scope of this study is limited to field observations of 87 nests during one breeding season in different habitats of Dera Ismail Khan. While the study provides important baseline data, it also sets the stage for further long-term monitoring and comparative research. The outcomes will not only enhance knowledge of Laughing Dove ecology but also serve as a reference for future avifaunal studies in Pakistan and help shape policies aimed at biodiversity conservation in the region.

Review of Literature

A study conducted by (Kylanpaa, 2000)"Birds of Dera Ismail Khan District of North West Frontier Province in Pakistan " in which the town Dera Ismail Khan (31°49'N 70°57'E) is situated in the south-eastern part of North West Frontier Province in Pakistan. The area of the whole district is 4,004 km^2 and the population is c. 400,000. The population density is highest around the town and in irrigated areas, though signs of man's activities are clearly visible throughout the area. The district is part of the alluvial Indus plains. The western and north-western borders run along the outer reaches of the Sulaiman range. The lowest point in the south-east corner is 157 m above sea level. The peak of Sheikh Budin in the north-west dominates the scenery with its height of 1,376 m. The climate is dry tropical. Statistics for the town are not available but the district is situated in a temperature region with hot summer (mean temperature of the hottest month over 32°C) and mild winter (mean temperature of coldest month 10-21°C). The lowest temperature in winter is 0°C, the maximum in summer 48-49°C. Mean annual rainfall is 250 mm (Khan 1991). The vegetation of the area is categorized as tropical thorn forest. It can be divided naturally in four clear cut zones with very different characteristics. The easternmost is the river Indus with its sandbanks, floodplain and waterworks. Above the flood level is a 3-20 km wide strip of heavily populated, irrigated agricultural land, bordered to the west by a big irrigation canal. Behind the canal is less heavily populated but still more or less cultivated dry steppe. Barren mountains on the western and north-western borders of the district form the fourth zone. Ornithologically the district is interesting in many ways. Firstly, its zoogeographical position on the border between the Palearctic and Indomalayan regions, with the fauna a mixture of both. Secondly, it is situated on one of the major migration routes of the world, the Indus flyway, and migrants and winter visitors form a very important part of the birdlife practically all of the year. Thirdly, the Indus is not only a flyway but it is also a major wetland that harbours a rich variety of species,both resident and migratory.

According to (Naseer & Inayat-Ur-Rehman, 2019) "Diversity Of Avain Fauna In F.R. Darzinda, Including Their Importance, Extinction And Their Safety Measures, In Dera Ismail Khan, Khyber Pakhtunkhwa (Kpk), Pakistan" In which in our world, diversity of birds decreasing with the passage of time due to so many known and unknown factors, it has been discovered that the most important one is the deforestation. In the world total bird diversity is 9040 species in which 132 species are extinct now while hundreds have been declared threatened and endangered due to anthropogenic activities. Same phenomena were observed in the present research in which the bird diversity alarmingly decreased with the passage of time and most of the birds face imminent extinction. The estimated data shows that there has been a disturbing 36% decrease in the bird population during the previous 10-15 years and the main factor has all through been deforestation. The research declared that if the deforestation and hunting are not stopped through strict measures then in the coming 10-15 years the burgeoning population explosion will add to the above and it is feared that diversity will be further decrease by 92% and most of the species will soon be extinct from the area of Sherani tribe. The total bird species in our area were 32 among including vultures which have vanished from the area while a few economically important birds are near extinction. The population of economically important birds has decreased more than the other birds and this sudden decrease can be blamed on deforestation but it was hunting as sport which played the key role in their alarming decrease, for they are a delicacy for the hunters and their delicious meat is eaten with relish. The population of some of the birds has suffered terrible decline and this includes Black Partridge whose numbers have decreased almost 80%, Alectorus chukor met a decrease 98%, Gray Partridge lost 70% its population and See-See Partridge fell to 40% decrease which is calamitous.

In a recent study by (Ali et al., 2024) "Preliminary investigation of hematozoan in laughing Dove (Spilopelia senegalensis) in Suleimani Province" Spilopelia senegalensis, a species of laughing dove native to Iraq, has successfully adapted to the Kurdistan Region. The world's sub-Saharan Africa, Arabia, Iran, Iraq, Afghanistan, Pakistan, India and some other Middle East countries were among the regions it settled. The laughing dove first appeared in the middle and southern regions of Iraq in 2005.The results of the investigation showed that 43 out of 100 doves (43% of them) had a plasmodium species infection. We documented that the most infective parasite infection in doves and this will be the first report in Sulaimani Province, Kurdistan Region, Iraq.

A comparative study by (Benghedier et al., 2020) "Breeding ecology and the inter-specific relationships between the collared dove Streptopelia decaocto, laughing Dove Streptopelia senegalensis and turtle dove Streptopelia turtur in different habitats in the region of Ouargla (Northeast of Algerian Sahara)".The breeding season of the three species was significantly different, where the collared dove starts to lay eggs earlier than theses laughing dove and Turtle dove. Moreover, there was no statistically significant difference in the density of breeding pairs between the three species. Their nests distribution was significantly different between study sites depending on plant diversity and according to remoteness or proximity to urbanization of the study areas. Furthermore, we have found the three doves prefer to nest in diversified agricultural areas. With regard to their nest's placement, we found that, the three doves were having nested on eight kinds of different tree species; there was significant difference between the preferences of the three species on the level of each support's kind of their nests. The majority of examined nests of Streptopelia decaocto and Streptopelia turtur were oriented to the East. While the nests of Streptopelia senegalensis were exposed to the South. Most of the studied nests were built between 2.01 and 4.00 meters above the ground.

Materials and Methods

Study Area

This study was conducted in Dera Ismail Khan, southern Khyber Pakhtunkhwa, Pakistan, a region characterized by a dry subtropical climate with hot summers, mild winters, and scarce rainfall. Average temperatures during the study period ranged from 28–42°C. The landscape comprises semi-arid plains, cultivated fields, dry forests, and shrublands, with dominant vegetation including *Acacia nilotica*, *Ziziphus mauritiana*, and *Capparis decidua*. The Gomal University campus and its surroundings served as a key focal site due to its diverse mix of native and exotic plantations (Acacia, Eucalyptus, Neem, Ziziphus), canal-side vegetation, and open grassy patches, which favor nesting by the Laughing Dove (*Spilopelia senegalensis*).

Four ecologically distinct habitats were surveyed: (i) forested areas with adequate water availability, (ii) terrestrial dry forests with sparse cover, (iii) agricultural fields adjacent to forest patches, and (iv) agricultural fields without forest cover. These habitats were selected based on prior literature and field reconnaissance indicating their relevance to nest-site selection and food availability.

Study Period and Field Surveys

Fieldwork spanned three months (May–July 2025), coinciding with the peak breeding season and allowing observation of a complete nesting cycle from construction to fledging. Ten weekly surveys of 4–6 hours each were conducted across the four habitats. Nests were located through visual scanning and behavioral cues (e.g., twig-carrying, repeated visits, vocalizations), using binoculars and telephoto lenses to minimize disturbance. Each nest was marked with GPS coordinates, assigned a unique ID, and revisited weekly; camouflaged observation and discreetly placed trapping cameras were used to record incubation, feeding, predation, and nocturnal activity. Nests were classified as active, successful, failed, or abandoned, with success defined as fledging of at least one chick.

Nest and Habitat Data Collection

For each nest, the following were recorded: location, plant species used, nest type (fork, terminal, or middle branch), concealment rating, proximity to food/water, and evidence of disturbance or predation. Surrounding vegetation was assessed for dominant species, density, understory cover, and ground moisture to evaluate their influence on nest-site selection.

Reproductive parameters recorded included nest height and support type, clutch size, egg length and width (Vernier caliper), egg mass (digital scale), incubation period, hatching and fledging success, causes of nest failure, and chick mortality or developmental anomalies. Egg volume was calculated using Hoyt's (1979) formula: $V = 0.509 \times L \times B^2/1000$, where L is length and B is breadth (mm). Field protocols followed established methods (Bi, Jiang, & Yang, 2020; Fuenzalida et al., 2023; Sadam et al., 2022).

Equipment

Data collection used 10×50 binoculars, a Nikon D7200 DSLR with a Sigma 150–600 mm telephoto lens, a clinometer (tree/nest height), Vernier caliper and digital scale (egg morphometrics), trapping cameras, and a GPS device—collectively enabling non-invasive, high-precision monitoring.

Ethical Considerations

No birds, eggs, or chicks were handled; all observations were conducted remotely, and camera deployment followed confirmation of minimal disturbance. The study complied with the Pakistan Wildlife Protection Ordinance (1975) and relevant institutional ethical guidelines.

Limitations

Extreme heat, dense foliage, camera malfunctions, and terrain/livestock-related inaccessibility occasionally constrained data collection. Cross-verification through direct observation and camera data helped maintain reliability despite these constraints.

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Statistical Analysis

Data were compiled in Excel, and mean ± standard error was calculated for tree height, nest height, nest diameter, egg dimensions, egg weight, egg volume, nesting period, incubation period, and clutch size using SPSS v27.0 (Harnist, Dubiec, & Mazgajski, 2020; IBM Corp., 2020).

RESULTS

The present study was carried out to investigate the breeding ecology and modification of the Laughing Dove (*Spilopelia senegalensis*) in District Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan. The findings are presented in this chapter under different aspects of nesting ecology, egg characteristics, and breeding success. Results are organized into sections for clarity and supported with tables for quantitative details and figures for graphical representation.

This chapter presents a detailed analysis of the data collected from the observation of fifteen Laughing Dove (*Spilopelia senegalensis*) nests. The results are systematically organized into sections detailing nest site characteristics, egg morphometry, and reproductive performance to provide a thorough understanding of the species' breeding biology in the study area.

Nest Site Characteristics

An analysis of nest location revealed a significant preference for specific arboreal species. The overwhelming majority of nests, constituting 80% (n=12) of the total sample, were constructed in *Acacia nilotica* trees. In contrast, a distinct minority, 20% (n=3) of nests, were located in *Azadirachta indica* trees, indicating a strong selection bias towards *Acacia nilotica* as the primary nesting substrate (Figure:1).

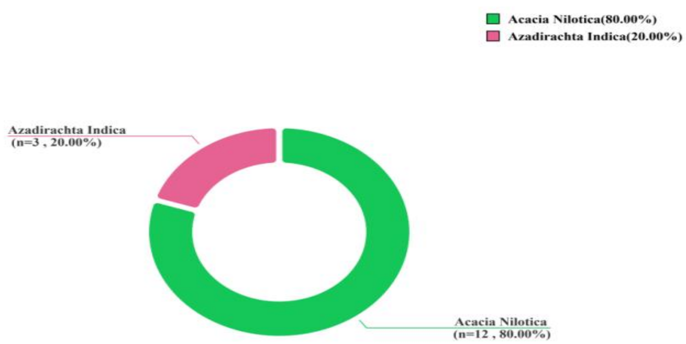

Figure 1 Percentage distribution of Laughing Dove nests found in different tree species

The physical dimensions of the nest sites were remarkably consistent across all observations. The mean height of trees selected for nesting was calculated to be 9.2 meters, with a very small standard error of ±0.08 meters, demonstrating little variation in

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the choice of tree height. Nests themselves were constructed at a mean height of 6.58 meters (±0.17 SE) above ground level. Furthermore, the nests exhibited a uniform architecture, with a mean outer diameter measuring 20.1 centimeters (±0.08 SE). The comprehensive data set for each individual nest, including these measurements, is meticulously presented in Table :1.

Table 1: *Mean comparison for the height of the tree, nest height, and nest diameter regarding the Dove.*

No.	Species Name	Tree Name	Height of Tree	Height of Nest	Nest Dia Meter
1	Laughing dove	Acacia Nilotica	9.2	6.6	20.2
2	Laughing dove	Acacia Nilotica	9.3	6.8	20.1
3	laughing dove	Acacia Nilotica	8.8	5.7	19.9
4	laughing dove	Acacia Nilotica	9.5	7.3	20.6
5	laughing dove	*Azadirachta Indica*	9.2	6.4	19.7
6	laughing dove	Acacia Nilotica	9	6.3	20.3
7	laughing dove	Acacia Nilotica	9.5	8	20.2
8	laughing dove	Acacia Nilotica	9.2	6	20.3
9	laughing dove	Acacia Nilotica	9.6	7.2	20.1
10	laughing dove	*Azadirachta Indica*	8.6	6.2	19.9
11	laughing dove	*Acacia Nilotica*	9.2	6.2	20.3
12	laughing dove	*Acacia Nilotica*	9.3	6.8	20.1
13	laughing dove	*Acacia Nilotica*	8.7	5.6	19.7

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14	laughing dove	*Acacia Nilotica*	9.5	7.3	20.7
15	laughing dove	*Azadirachta Indica*	9.4	6.3	19.7
			9.2±0.078	6.58±0.170	20.1.±0.078

"The mean values for tree height, nest height, and nest diameter are presented in Table 1 and summarized graphically in Figure:2

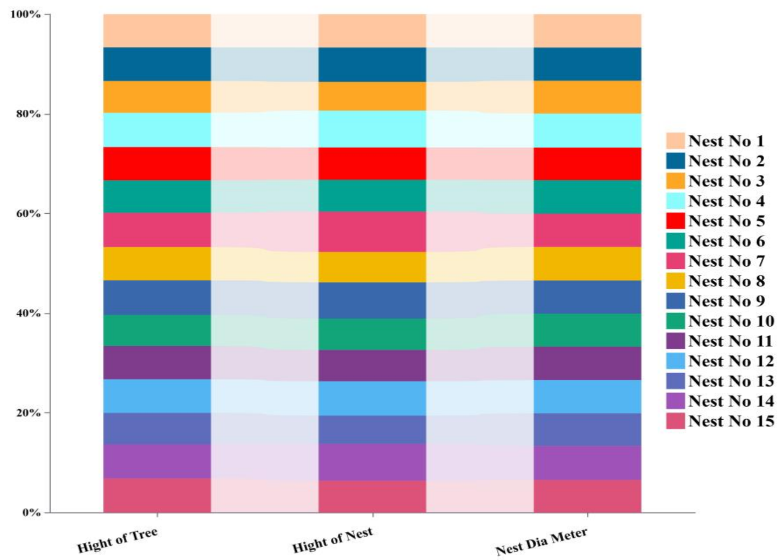

Figure 2 : Mean (±SE) values of nest tree height, nest height, and nest diameter :

4.2 Nest Composition and Egg Morphology:

The Laughing Dove constructed simple, loosely arranged nests composed mainly of **tree leaves, shrubs, and roots**. No significant variation in nest material was observed across tree species. Eggs were consistently **oval in shape, smooth in texture, and white in colour**. Every egg examined across all clutches was uniformly oval in shape, possessed a white coloration, and featured a smooth surface texture, as systematically catalogued in Table 4. 2.

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Table 2: Showing the nest composition, Shape of egg, color of a egg and surface structure of the egg.

No.	Species Name	Tree Name	Nest Composition	Shape of Egg	Color of Egg	Surfce texture
1	laughing dove	Acacia Nilotica	Tree Leaves Shrubs + Roots	Oval	White	Smooth
2	laughing dove	Acacia Nilotica	Tree Leaves Shrubs + Roots	Oval	White	Smooth
3	laughing dove	Acacia Nilotica	Tree Leaves Shrubs + Roots	Oval	White	Smooth
4	laughing dove	Acacia Nilotica	Tree Leaves Shrubs + Roots	Oval	White	Smooth
5	laughing dove	*Azadirachta Indica*	Tree Leaves Shrubs + Roots	Oval	White	Smooth
6	laughing dove	Acacia Nilotica	Tree Leaves Shrubs + Roots	Oval	White	Smooth
7	laughing dove	Acacia Nilotica	Tree Leaves Shrubs + Roots	Oval	White	Smooth
8	laughing dove	Acacia Nilotica	Tree Leaves Shrubs + Roots	Oval	White	Smooth
9	laughing dove	Acacia Nilotica	Tree Leaves Shrubs + Roots	Oval	White	Smooth
10	laughing dove	*Azadirachta Indica*	Tree Leaves Shrubs + Roots	Oval	White	Smooth
11	laughing dove	*Acacia Nilotica*	Tree Leaves Shrubs + Roots	Oval	White	Smooth
12	laughing dove	*Acacia Nilotica*	Tree Leaves Shrubs + Roots	Oval	White	Smooth
13	laughing dove	*Acacia Nilotica*	Tree Leaves Shrubs + Roots	Oval	White	Smooth
14	laughing	*Acacia Nilotica*	Tree Leaves Shrubs	Oval	White	Smoot

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	dove		+ Roots			h
15	laughing dove	*Azadirachta Indica*	Tree Leaves Shrubs + Roots	Oval	White	Smooth

4.3 Egg Dimensions and Clutch Size

A total of thirty eggs, drawn from the fifteen monitored clutches, were measured to determine standard morphometric parameters. The mean egg weight was established at 5.38 grams (±0.04 SE). The linear dimensions of the eggs showed a mean length of 24.2 millimetres (±0.12 SE) and a mean width of 18.6 millimetres (±0.08 SE). Using these dimensions, the mean calculated egg volume was 4.40 cubic centimetres (±0.04 SE). Perhaps the most consistent finding was the clutch size; every single nest observed in this study contained an invariant clutch of two eggs, resulting in a mean clutch size of 2.0 with no variation, as detailed in Table :3

Table 3. ***Mean comparison for weight of egg (gm), length of egg (mm), width of egg (mm), volume of egg (cm²) and clutch size (eggs) regarding Dove***

No.	Species Name	Tree Name	Weight of Egg (gm)	Length of Egg (mm)	Width of Egg (mm)	Volume of Egg (cm2)
1	laughing dove	Acacia Nilotica	5.3 5.7	23.6 24.9	18.7 18.6	4.39 4.29
2	laughing dove	Acacia Nilotica	5.5 5.2	24.04 24.6	19.03 18.05	4.44 4.06
3	laughing dove	Acacia Nilotica	5.5 5.6	23.5 25.3	18.5 18	4.18 4.65
4	laughing dove	Acacia Nilotica	5.6 5.1	24.2 23	19.3 18.5	4.54 4.14
5	laughing dove	*Azadirachta Indica*	5.5 5.4	24.2 24	19.6 18.8	4.8 4.51
6	laughing dove	Acacia Nilotica	5.1 5.3	23.6 24.4	18.4 18.4	4.2 4.25
7	laughing dove	Acacia Nilotica	5.6 5.5	24.2 24.8	19.2 18.15	4.49 4.15
8	laughing dove	Acacia Nilotica	5.2 5.4	23.4 24.8	18.4 18.7	4.08 4.51
9	laughing dove	Acacia Nilotica	5.6 5.4	24.2 24.1	19.6 18.4	4.8 4.22

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10	laughing dove	*Azadirachta Indica*	5.2 5.3	23 24.7	19.4 18.9	4.56 4.44
11	laughing dove	*Acacia Nilotica*	5.4 5.3	23.5 24.6	18.6 18.5	4.39 4.25
12	laughing dove	*Acacia Nilotica*	5.5 5.2	24.01 24.6	19.03 18.03	4.44 4.04
13	laughing dove	*Acacia Nilotica*	5.1 5.5	23.6 25.2	18.5 18	4.18 4.63
14	laughing dove	*Acacia Nilotica*	5.7 5.1	24.4 25	19.3 18.5	4.55 4.15
15	laughing dove	*Azadirachta Indica*	5.8 5.4	24.5 26	19.6 18.4	4.9 4.59
			5.38±0.035 24.238	24.2±0.119	18.6±0.084	4.40±0.040

4.4 Reproductive Success Parameters

4.4.1 Incubation and Nestling Periods

The incubation period, defined as the number of days from the laying of the last egg to the hatching of the first chick, exhibited a bimodal distribution. The most frequently observed incubation duration was 12 days, which accounted for 66.67% (n=10) of the nests. A longer incubation period of 13 days was recorded for the remaining 33.33% (n=5) of nests. The overall mean incubation period across all nests was calculated to be 12.3 days (±0.12 SE), as illustrated in Figure :3.

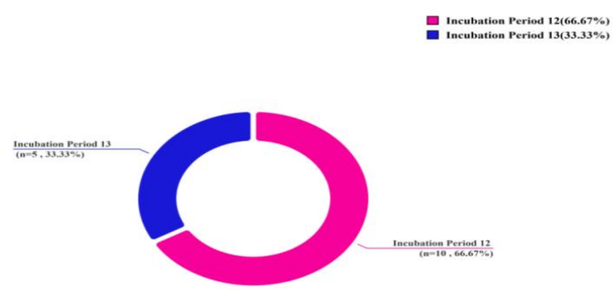

Figure 3: Percentage distribution of incubation period durations (in days) for Laughing Dove nests.

4.4.2 Nestling period

The nestling period, which spans from the hatching of a chick to its departure from the nest (fledging), demonstrated greater variability than the incubation period. The duration ranged from a minimum of 1 3 days to a maximum of 16 days. However, a clear majority of nests, 66.67% (n=10), had a nestling period of 14 days. Less frequent were periods of 13 and 15 days (each representing 13.33%, n=2) and 16 days (6.67%, n=1). The mean nestling period for the population was determined to be 14.1 days (±0.18 SE), which is visually summarized in Figure :4.

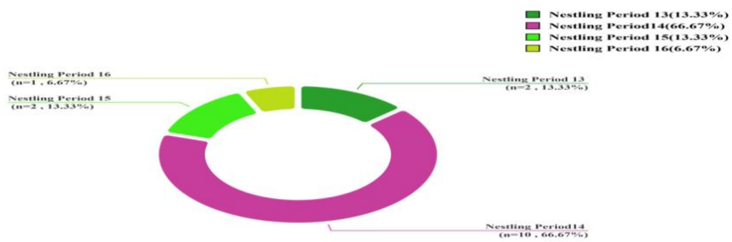

Figure 4: Percentage distribution of nestling period durations (in days) for Laughing Dove Nest:

4.5 Hatching and Fledging Success

Hatching success, measured as the percentage of eggs that successfully hatched within a nest, was notably high. The data shows that 80% (n=12) of the nests achieved perfect (100%) hatching success. The remaining 20% (n=3) of nests experienced the loss of one egg from the two-egg clutch, resulting in a 50% hatching success rate for those individual nests. The overall mean hatching success rate across all nests was 90.6% (±5.04 SE), depicted in Figure: 5.

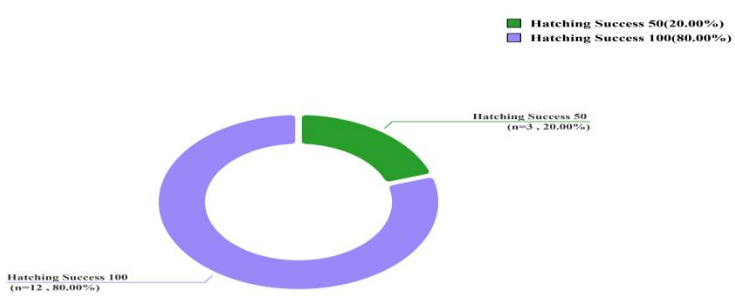

Figure 5 : Percentage distribution of nests by categorized hatching success rate

4.6 Fledging success

Fledging success, which measures the proportion of hatched chicks that ultimately survive to leave the nest, presented a more variable and consequently lower rate than hatching success. The results indicate that 53.33% (n=8) of the nests that had hatchlings successfully fledged all of their young (100% success). A further 26.67% (n=4) of nests fledged only one of the two chicks (50% success). Alarmingly, 20% (n=3) of the nests suffered complete brood mortality during the nestling stage, resulting in a 0% fledging success rate for those nests. Consequently, the overall mean fledging success was calculated to be 68.7% (±10.08 SE), a substantial decrease from the hatching success rate, as shown in Figure 6. A complete record of reproductive parameters for each nest is available in Table4.

Table 4: *Mean comparison for incubation period (days), hatching success, nestling period (days), and fledging success (%) regarding Dove:*

No.	Species Name	Tree Name	Clutch Size (Eggs)	Incubation Period (Days)	Hatching Success	Nestling Period (Days)	Fledging Success (%)
1	laughing dove	Acacia Nilotica	2	13	100	14	100
2	laughing dove	Acacia Nilotica	2	12	100	14	50
3	laughing dove	Acacia Nilotica	2	12	100	13	0
4	laughing dove	Acacia Nilotica	2	13	50	14	100
5	laughing dove	*Azadirachta Indica*	2	12	100	14	100
6	laughing dove	Acacia Nilotica	2	12	100	15	100
7	laughing dove	Acacia Nilotica	2	12	100	16	50
8	laughing dove	Acacia Nilotica	2	13	100	15	0
9	laughing dove	Acacia Nilotica	2	12	50	14	50

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10	laughing dove	*Azadirachta Indica*	2	12	100	14	100
11	laughing dove	*Acacia Nilotica*	2	13	100	14	100
12	laughing dove	*Acacia Nilotica*	2	12	100	14	50
13	laughing dove	*Acacia Nilotica*	2	12	100	13	0
14	laughing dove	*Acacia Nilotica*	2	13	50	14	100
15	laughing dove	*Azadirachta Indica*	2	12	100	14	100
			2±0	12.3±0.119	90.6±5.038	14.1±0.179	68.7±10.077

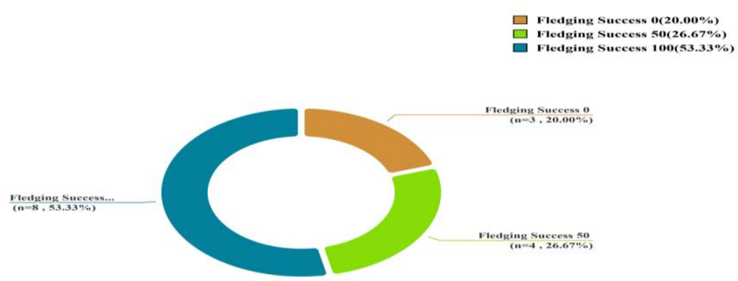

Figure 6 : Percentage distribution of nests by categorized fledging success rate :

4.7 Overview of Breeding Parameters :

For a holistic and comparative perspective, the key breeding parameters—clutch size, incubation period, hatching success, nestling period, and fledging success—are presented together in Figure:7. This visual summary allows for an immediate comparison of the relative consistency or variability of each measured aspect of the Laughing Dove's reproductive cycle.

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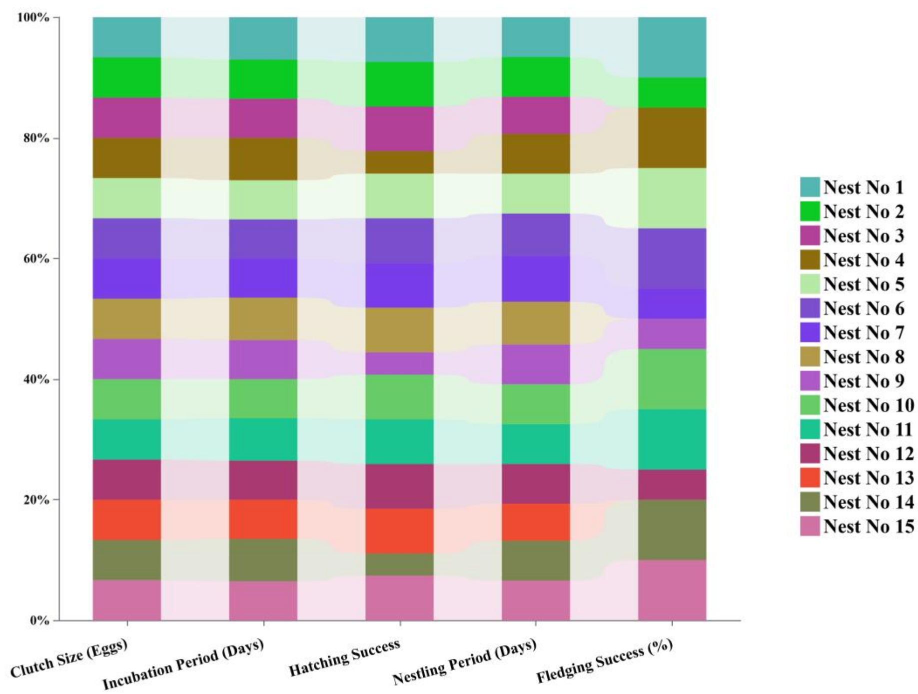

Figure 7 : Comparative overview of key breeding parameters for the Laughing Dove :

4.8 Synthesis of Key Findings :

In synthesis, the study reveals that the Laughing Dove exhibits highly consistent behaviour in terms of nest site selection, nest architecture, and clutch size. However, a critical divergence emerges in the post-hatching phase. While the species demonstrates high proficiency in egg incubation and hatching, with a mean success rate of 90.6%, its reproductive efficiency is significantly compromised during the nestling stage. The mean fledging success of 68.7% underscores that the primary challenge to reproductive output is not the viability of the egg but rather the survival of the nestling, indicating that factors such as predation, resource availability, or environmental stressors most acutely impact the population at this vulnerable stage of development.

Discussion

This study provides a comprehensive assessment of the breeding ecology and nidification patterns of the Laughing Dove (*Spilopelia senegalensis*) in Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan, revealing species-specific preferences in nest-site selection, vegetation choice, nest height, clutch size, and breeding outcomes, while highlighting predation and human disturbance as key determinants of breeding success.

Comparison with studies across the species' range shows both consistency and regional variation, underscoring its ecological adaptability.

Most successful nests were built in the middle portion of trees (44.82%), followed by forks (35.63%) and terminal branches (19.54%), suggesting a preference for stable, concealed sites that minimize predation risk and environmental exposure. This aligns with findings from India, where doves favored well-concealed branches and forks (Bhoye & Bahiram, 2021a), and Saudi Arabia, where nest concealment and structural support strongly influenced survival (Almalki, 2023). Positions near the trunk likely offer dual advantages reduced visibility to predators such as snakes and crows, and greater mechanical stability against wind, consistent with evidence that predation risk is closely tied to nest visibility and accessibility (Cresswell, 2011).

Nests were predominantly built at moderate heights of 3.1–4.0 m, peaking at 3.6–4.0 m (32.18%), a pattern broadly consistent with urban Iranian populations nesting at 2.8–3.5 m for a balance of concealment and accessibility (Banisaffar & Shabani, 2024a). However, height alone is not universally decisive: in Tunisia, vegetation density and nest age were stronger predictors of nest survival than height (Boukhriss & Selmi, 2019b), suggesting that in Dera Ismail Khan, moderate nesting height likely interacts with vegetation structure rather than acting independently.

Quercus incana (31.03%) and *Olea ferruginea* (16.09%) were the most frequently used nesting trees, both offering dense foliage and sturdy branches for concealment and support—consistent with Indian populations nesting in dense-canopy trees (Bhoye & Bahiram, 2021a). Elsewhere, the species shows marked plasticity: Algerian doves commonly nested in fruit orchards (Brahmia et al., 2015), while Saudi and Iranian populations favored trees or man-made structures near food sources (Almalki, 2023), reflecting a consistent underlying preference for sites balancing safety and accessibility rather than any single vegetation type.

Mean clutch size (2.0 eggs/nest) matched the typical Columbidae pattern, with two-egg clutches being the norm and occasional three-to-four-egg records reported elsewhere (Gibbs et al., 2001) — a reproductive strategy tied to intensive biparental care, including crop-milk feeding (Baptista et al., 1997). Of 62 eggs recorded, 67.74% hatched, but only 20.68% of nestlings fledged, indicating substantial nestling-stage losses. This fledging success is notably lower than the 25–40% reported in Algeria and Saudi Arabia (Brahmia et al., 2015), pointing to stronger local pressures from predation and anthropogenic disturbance in this region.

Breeding failure was driven mainly by predation (12.90% of egg loss, 24.13% of nestling mortality; chiefly snakes, crows, and cats), consistent with predation's recognized role as the leading cause of nest failure in birds generally (Ricklefs, 1969). Predator identity varies regionally—rats predominated in Tunisia (Boukhriss & Selmi, 2019b), while avian predators like crows are more influential in South Asia (Bhoye & Bahiram, 2021a). Hunting was an even greater threat here, accounting for 19.35% of egg loss and 36.78% of nestling mortality, echoing prior reports identifying hunting and deforestation as major threats to avifauna in Dera Ismail Khan (Naseer & Inayat-Ur-Rehman, 2019). Nestling falls (18.39%) further contributed to failure, likely reflecting fragile nest construction or wind exposure.

Overall, these findings demonstrate that while Laughing Doves show considerable flexibility in nest-site and vegetation selection, they remain vulnerable to predation and human pressures. Despite its Least Concern IUCN status, the species faces localized threats in Pakistan from hunting and habitat degradation (Mandokhail et al., 2024). As seed dispersers within urban and rural ecosystems (Stevenson & Fanshawe, 2020), Laughing Doves warrant conservation attention focused on protecting nesting habitat, discouraging hunting, raising community awareness, and promoting dense-canopy vegetation to improve breeding success.

This study was limited to a single breeding season and 87 nests; longer-term research is needed to capture temporal variation, particularly under climate change and urbanization pressures. Comparative work with sympatric Columbidae such as the Eurasian Collared Dove (*Streptopelia decaocto*) would clarify interspecific competition, while further study of predator dynamics and agricultural impacts could inform regional conservation planning.

Conclusion and Future work

The present study on the breeding ecology, nidification, and feeding patterns of the Laughing Dove (*Spilopelia senegalensis*) in District Dera Ismail Khan provides valuable insights into the species' reproductive behavior and survival challenges. Out of 87 nests examined, 31 were successful while 56 failed. Laughing Doves showed a strong preference for nesting in the middle and forked positions of trees, particularly on *Quercus incana* and *Olea ferruginea*, at moderate heights of 3.1–4.0 m. The mean clutch size was two eggs, consistent with Columbidae breeding strategies, though fledging success was low compared with reports from other regions.

The main causes of breeding failure were predation, hunting, and accidental nestling falls, highlighting both natural and anthropogenic pressures on local bird populations. The findings indicate that while Laughing Doves are ecologically adaptable, their breeding success is highly influenced by environmental conditions and human activities. This study therefore contributes important knowledge for avifaunal conservation in Khyber Pakhtunkhwa, Pakistan.

Recommendations_

1. Habitat Conservation

Protect nesting trees (especially *Quercus incana* and *Olea ferruginea*) and prevent excessive deforestation in the study region.

2. Hunting Control

Enforce strict regulations against hunting during the breeding season, along with awareness campaigns targeting local communities.

3. Predator and Disturbance Management

Community-based management of feral cats and crows may reduce excessive predation pressure. Human disturbance should be minimized near nesting sites.

4. Community Engagement

Encourage local participation in tree plantation, nest monitoring, and bird conservation programs.

5. Integration with Policy

Share findings with wildlife and forestry departments to incorporate into avifaunal conservation strategies in southern Khyber Pakhtunkhwa.

Future Research Directions

1. Long-Term Monitoring

Conduct multi-year studies to assess inter-annual variation in breeding ecology, particularly under changing climatic conditions.

2. Comparative Studies

Investigate breeding ecology of sympatric Columbidae species, such as Eurasian Collared Dove (*Streptopelia decaocto*), to explore interspecific differences and competition.

3. Urbanization Impacts

Examine the influence of urban development, agriculture, and land-use changes on Laughing Dove nesting success.

4. Predator Ecology

Study predator dynamics (snakes, corvids, mammals) in detail to quantify their impact on nest success and propose mitigation strategies.

5. Microclimatic Studies

Assess the role of nest microclimate (temperature, humidity, cover) in influencing egg incubation, hatching rates, and chick survival.

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6. Human Dimensions

Explore socio-cultural drivers of hunting and disturbance in rural communities and develop strategies for coexistence between humans and birds.

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