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Foraging behaviour and diet composition of grey francolin, *Ortygornis pondicerianus*, during breeding and non-breeding seasons

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Abstract

This study investigated the foraging behaviour and diet composition of grey francolin (*Ortygornis pondicerianus*) in different seasons (breeding and non-breeding) and habitats (agricultural land, tree-covered land, shrubland, and barren land). Focal sampling and faecal analysis methods were employed to examine the foraging behaviour and diet composition of the grey francolin, respectively. Foraging techniques showed non-significant ($p=0.829$) variation across different habitat types; however, walk-halt-peck (WHP) was the most commonly utilized foraging technique across all habitats. Additionally, foraging success varied significantly across seasons ($p<0.05$) and habitats ($p<0.05$). We recorded significantly higher feeding rates in the shrubland during the breeding season. The percentage of successful attempts was significantly higher ($p<0.05$) in the breeding season compared to the non-breeding season. Furthermore, faecal analysis results showed a significant ($p<0.05$) difference in composition between plant and animal matter, especially during the breeding season. However, the grit content showed non-significant variation ($p>0.05$) across seasons.

Keywords

faecal analysis, foraging success, habitat, pecking, scratching

Introduction

The grey francolin (*Ortygornis pondicerianus,* Phasianidae) is a galliform native to South Asia and parts of the Middle East.[1] Additionally, it has been introduced to various regions worldwide, including parts of the Middle East, the British Indian Ocean Territory, and North America.[2,3] The grey francolin has a black bill, brownish-orange legs, a buffy throat with black borders, and prominent chestnut outer rectrices in flight.[4] Males are larger with a single spur, while females lack spurs.[4] Grey francolin inhabits cultivated lands with dense bushes for shelter, as well as dry habitats such as woody ravines, grasslands, fallow fields, dry lakes, canals, and harvested crops, while avoiding areas near human dwellings.[5,6] Foraging behaviour of francolins is interesting primarily because it provides insights into their adaptability, their ecological role, and the impact of environmental changes on their survival.

Foraging in birds encompasses a series of behavioural activities, including searching, pursuing, assessing, and handling, which result in the ultimate consumption of food.[7] Ground-dwelling birds spend a significant portion of their day engaged in foraging activities,[8,9] However, the methods an animal uses to acquire and consume food or their foraging techniques may be highly variable across seasons, sexes, and populations.[10] This is so, as bird adapt their foraging techniques based on prey availability, habitat structure, and individual requirements.[11]

Foraging behaviour in birds is largely influenced by their morphology, which allows them to exploit food resources specific to their habitats.[12] Adaptations such as specialized beak shapes, leg strength, and foot structure enable these birds to efficiently peck, scratch, and probe through soil and leaf litter to access hidden prey and plant material.[13] These morphological traits form the foundation of species-specific foraging strategies, which must remain flexible in response to seasonal ecological pressures.[14] Foraging behaviour is also affected by temporal changes, particularly between the breeding and non-breeding seasons.[14] During the breeding season, variations in resource availability necessitate adaptive foraging techniques to optimize energy expenditure and support reproductive success.[15]

Galliform birds have specialized foraging techniques such as pecking, probing, and scratching, each adapted to specific substrate conditions and types of prey.[8,16] Pecking involves striking visible prey with the beak, while probing facilitates extraction from soil or leaf litter, and scratching

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uncovers concealed food resources.[16] These foraging techniques play a crucial role in the birds' foraging success, as measured by the percentage of successful attempts to consume food.[17] Foraging success further depends on the birds' ability to adjust their techniques in response to changing ecological conditions.[17]

Food availability and selection play crucial roles in survival and reproductive success.[18] Seasonal variation in biotic and abiotic factors alters resource distribution, directly impacting food availability across habitats.[19] Birds respond to these variations through interspecific and spatiotemporal shifts in diet composition, reflecting ecological flexibility and adaptive foraging behaviour.[20] During breeding season, birds require substantial energy to support the development of eggs and the rearing of chicks, making food resources vital for successful reproduction.[18] Moreover, seasonal changes in habitat structure and vegetation dynamics can influence prey accessibility,[21] further shaping diet breadth and foraging strategies.[22]

Francolins, being omnivorous generalist feeders, select a wide range of plant and animal-based food items depending on seasonal availability.[23] In grey francolins, based on crop content analysis, plant material may dominate the diet,[24] while insect-based prey constitutes a substantial part of the diet.[25] Faecal analysis is widely used in avian diet studies due to its efficiency in sample collection and comparative analysis over time.[26] However, it has limitations, particularly in under-representing soft-bodied prey due to differential digestibility.[27] Despite their ecological flexibility, there is limited information on how their foraging behaviour (technique and success) and diet vary across seasons. Therefore, in this study, we aimed to determine changes in foraging techniques and success across habitats and seasons, as well as seasonal variation in the diet composition of grey francolins using faecal analysis. Hence, we hypothesized that grey francolins would exhibit consistent foraging behaviour (techniques and success) across habitats and seasons. Furthermore, we expected them to maintain a generalist diet during both breeding and non-breeding periods.

Methodology

Study area

The field study was conducted during the breeding season (April-September) and the non-breeding season (October-March) from 2022 to 2024 in the Lucknow district (26.7863° N, 80.8987° E), Uttar Pradesh, India (Figure 1). Lucknow district spans 2528 square km, with most of the land classified as agricultural, followed by built-up areas, vegetation and forests, shrubland, barren land, and water bodies (Figure 1). The climate of the study area is subtropical, with an average annual temperature of 25.1°C (77.2°F), and the mean annual rainfall is 1000 mm (39.3 inches) (ref. 28).[28] The Gomti is the major river, along with other water bodies such as the Sharda canal, Kukrail, and Sai River, all of which support local agriculture by providing essential water resources. Based on physiognomic features, the study area was divided into four habitats, namely: agricultural land, tree-covered land, shrubland, and barren land. These habitats support a diverse range of food sources, including various groups of arthropods such as Blattodea (termites), Hymenoptera (ants), Coleoptera (beetles), Dermaptera, Hemiptera, Lepidoptera, Orthoptera, and Araneae, etc.[29] Additionally, the region sustains multiple crop types, including wheat, rice, maize, millets, pulses, and oilseeds. The vegetation comprises a rich assemblage of shrubs, herbs, and trees, including *Ficus benghalensis, Azadirachta indica, Mangifera indica, Psidium guajava, Ficus religiosa, Bauhinia racemosa, Syzygium cumini, Ziziphus mauritiana, and Acacia spp*.[30] Based on survey results showing frequent francolin sightings, five sites were selected for bird observations and data collection: Gosainganj (26.7971°N, 81.1025°E), Malihabad (26.8601°N, 80.7577°E), Banthra (26.7176°N, 80.8145°E), Nigohan (26.6146°N, 81.0407°E), Bakshi Ka Talab(27.0740°N, 80.9147°E) (Figure 1).

Data collection

Study design. We deployed five line transects (500 to 1500 m in length) covering an area of 5 square km in each study site, covering all possible microhabitats for recording foraging behaviour and collecting faecal samples. Transects were surveyed during both breeding and non-breeding seasons. No individuals were tagged or captured during the field investigations. We determined francolin's foraging sites by direct (visual observation) and indirect (vocalisation and feather traces) methods.

Foraging behaviour observation. We adopted a focal sampling method to evaluate foraging behaviours.[31] Observations were made with the aid of binoculars (Bushnell Falcon 10×50 magnification), a stopwatch, a range finder (SToK ST-LDM100), and a video recorder (Canon 1100D digital camera with 60× zoom capability), concealed in a nearby blind and unaided visual observation.[31,32] Data were excluded from analysis if the focal individual ceased foraging or disappeared before completing one minute of the five-minute observation period.[33] All-occurrence sampling was briefly interrupted every five minutes for a scan sample or when the focal bird engaged in behaviours other than foraging.[31] The total observation during the entire study period of the grey francolin constituted 545 minutes. When most of the birds were engaged in feeding activities,[34] focal samplings were conducted at each site in triplicate, between 06:00 and 18:00. All study sites were surveyed once per month, during different seasons (breeding and non-breeding). We recorded 57 grey francolins foraging at various study locations. All observations were carried out under calm weather conditions.[35]

In this investigation, the foraging behaviour of the grey francolin consisted of foraging techniques and success. Techniques were primarily categorised as pecking and probing. Pecking was defined as bill penetration into the substrate to less than one-quarter of its total length,[36] whereas probing involved bill penetration exceeding one-quarter of its total length.[37] Furthermore, in scratching, birds typically use their bill and feet

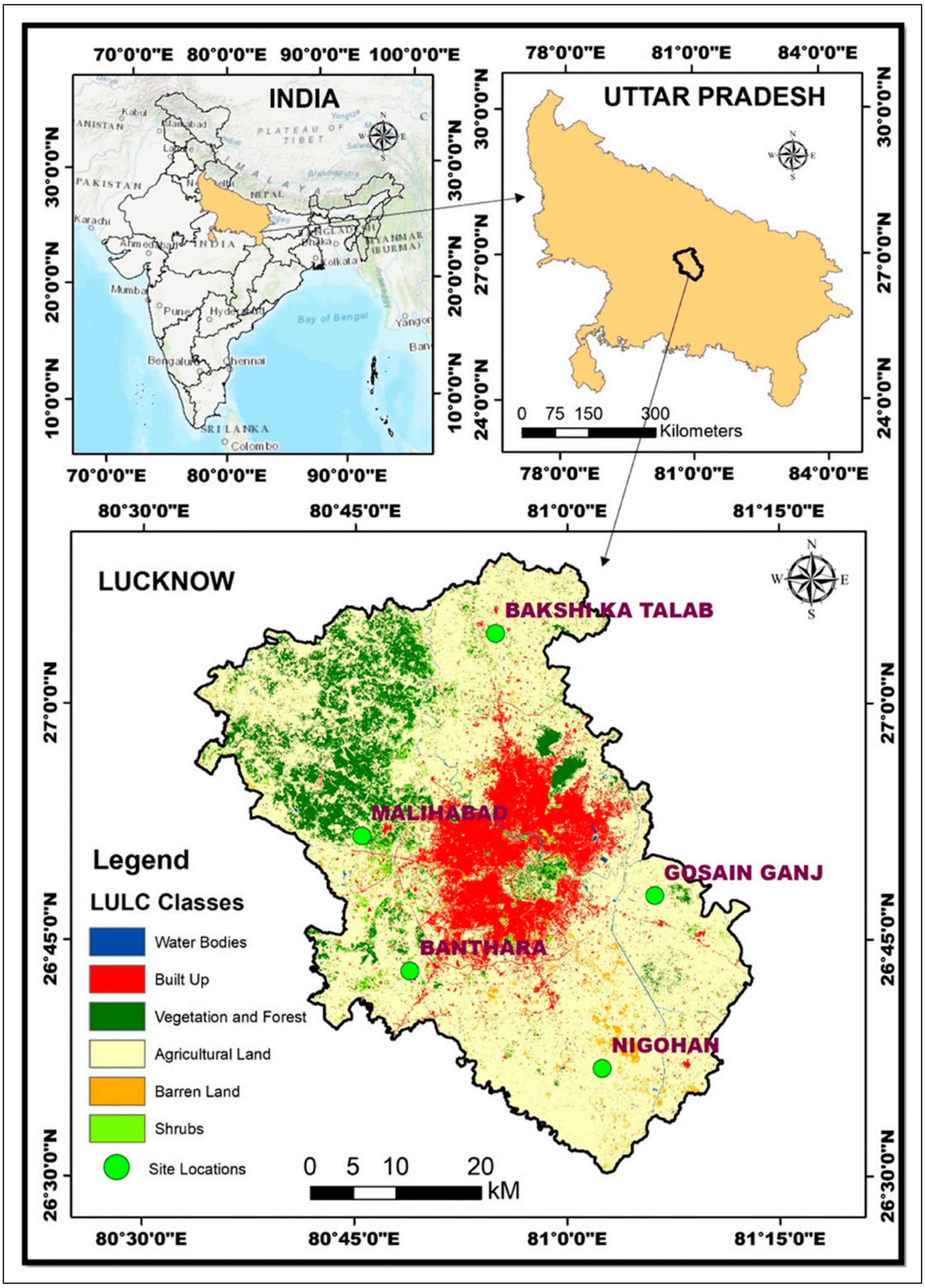

Figure 1. Land use land cover map of the study area.

to forage beneath the leaf litter and ground surface.[38] Foraging techniques were further re-classified as walk-halt-peck (WHP), walk-halt-scratch-peck (WHSP), walk-halt-probe-peck (WHPP), walk-halt-scratch-probe-peck (WHSPP). Foraging success was assessed using four components: (1) Walking rate, defined as the number of steps per minute; (2) Foraging or feeding rate, measured as the total number of feeding attempts (pecks) per minute; (3) Foraging success rate, calculated as the number of prey items consumed per minute; and (4) Percent attempt success, estimated as number of feeding attempts results in prey consumption per bird per minute divided by the sum of feeding attempts per bird per minute, and multiplied by 100. The number of pecks per minute accurately indicated eating rates, as each peck at the foraging substrate was considered as a discrete feeding attempt.[39]

Faecal sample collection. In the present study, fresh faecal pellets were collected following direct observation of individual grey francolins defecating at foraging sites, thereby ensuring species-level accuracy and minimising the risk of misidentification with faeces from other avian species; to avoid sample duplication, only one faecal sample was collected per study site per month across different seasons (breeding and non-breeding). Since the faecal samples were collected across multiple sites and seasons, each sample originated from a distinct individual. Faecal samples were collected in 2-ml microcentrifuge tubes and kept at room temperature in a solution comprising 70% ethanol, 5% glycerol, and 25% water. Samples were dried in an oven at 60°C for 24 hours to remove residual moisture. For analysis, dried pellets were transferred into petri dishes, and large pieces were carefully dissected using a needle and forceps to prepare them for analysis.[40] A stereo-microscope (20X magnification) was used to examine the fragments for identifiable animal and plant remains. Taxonomic identification was conducted following established protocols and identification keys provided by previous researchers.[41,42]

We calculated the number (Mean±S.D) of food items classified as animal, plant, and grit parts, based on faecal samples collected across the breeding and non-breeding seasons. Foraging behaviour was assessed through direct visual observation at the site and indirectly via the recorded videos. The VLC 3.0.21 media player was used to analyse the video sequences in slow motion on a computer screen. The frequency (Mean±SE.) of foraging techniques and success was estimated across seasons and study sites. The data were combined because all research locations were identical, containing every sort of microhabitat.

Statistical analysis

Kolmogorov-Smirnov, Levene's, and Shapiro-Wilk tests were employed to check the data for homogeneity and normality, respectively. We performed a one-way ANOVA (parametric) followed by Tukey's post hoc test to examine foraging behaviour (techniques and success) in different habitats. Additionally, an independent samples t-test (parametric) was applied to evaluate foraging behaviour (techniques and success) across seasons (breeding and non-breeding). Similarly, an independent samples t-test (parametric) was conducted to examine variation in faecal matter across different seasons. All statistical analyses were performed using SPSS software (Version 27).

Results

Foraging behaviour

In this field investigation, we considered 109 individuals of grey francolin actively engaged in foraging. No significant difference was found in grey francolin feeding technique across four habitats ($F = 29.53$, $df = 3$, $p = 0.829$) (Figure 2). Overall, it was shown that walk-halt-peck (WHP) was the most frequently used foraging technique across all habitats (post-hoc test, $p<0.05$), whereas walk-halt-scratch-probe-peck (WHSPP) was the least frequently used strategy (post-hoc test, $p<0.05$) (Figure 2).

The WHP technique was the most utilized (post-hoc test, $p<0.05$) in agricultural land, while the least (post-hoc test, $p<0.05$) in barren land (Figure 2). Similarly, the walk-halt-probe-peck (WHPP) technique was estimated to be significant (post-hoc test, $p<0.05$) in agricultural and non-significant (post-hoc test, $p>0.05$) in barren land (Figure 2). Furthermore, the WHSP technique was recorded at its highest (post-hoc test, $p < 0.05$) in tree-covered land, and at its lowest (post-hoc test, $p > 0.05$) in barren land (Figure 2). Similarly, the WHSPP technique was the most frequently observed (post-hoc test, $p<0.05$) in barren land, while it was the least frequently observed (post-hoc test, $p>0.05$) in agricultural land (Figure 2). In conclusion, there was no significant difference in the foraging techniques of grey francolins between the breeding and non-breeding seasons ($t = 1.09$, $p = 0.746$) (Figure 2).

The movement rate had been estimated to be significant (post-hoc, $p<0.05$) across habitats. (Table 1). A statistically significant ($F = 27.457$, $df = 3$, $p = 0.027$) disparity in foraging success was observed among habitat types (Table 1). Foraging success has been estimated to be significant (post-hoc, $p<0.05$) in shrubland and non-significant (post-hoc, $p>0.05$) in barren land (Table 1). Foraging success during the breeding season was significant ($t = 2.243$, $p = 0.035$) (Table 1). Similarly, the feeding rate was maximum (post-hoc, $p<0.05$) recorded in the shrubland, while minimum in (post-hoc, $p>0.05$) barren land (Table 1). The percentage of successful attempts was significant (post-hoc, $p<0.05$) in shrubland and non-significant (post-hoc, $p>0.05$) in barren land (Table 1).

Diet

To examine diet composition, 120 faecal samples were collected (30 samples from each breeding and non-breeding seasons) across study sites. The results exhibited the presence of animal, plant, and grit matter (Table 2). The percentage of plant material (6.912±0.246) had dropped considerably during the breeding season ($t = 2.57$, $p = 0.028$) compared to the non-breeding season (Table 2). Additionally, the proportion of animal matter spanned (4.604 ± 0.301) significantly ($t = 5.37$, $p = 0.016$) during the breeding season (Table 2). However, grit content showed non-significant ($t = 0.81$, $p = 0.437$) variation in breeding (1.198±0.059) and non-breeding season (1.170±0.060) (Table 2).

Discussion

In this field study, grey francolin (*Ortygornis pondicerianus*) was selected to investigate its foraging behaviour (techniques and success) and diet composition. In Galliformes, pecking is exclusively used for food intake, while other behaviours, such as scratching and probing, serve as search techniques to locate and assess potential prey.[43]

Foraging technique

We found that WHP was the most utilised technique across all habitat types, whereas WHSP, WHPP, and WHSPP

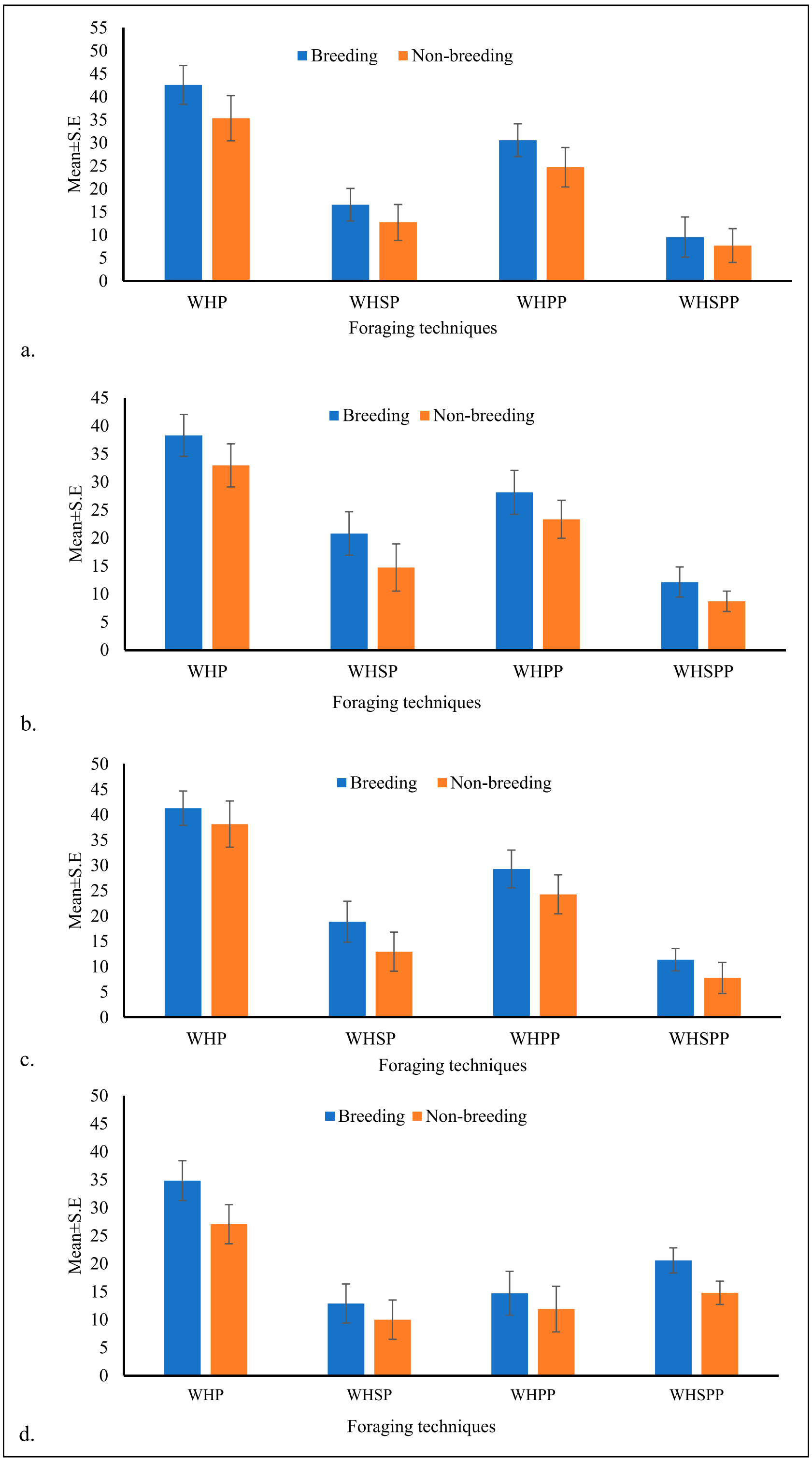

Figure 2. Estimation of foraging techniques (Mean±S.E) of grey francolin in different habitats and seasons: (a) Agricultural land; (b) Tree-covered land; (c) Shrubland; (d) Barren land. WHP = Walk-halt-peck, WHSP = Walk-halt-scratch-peck, WHPP = Walk-halt-probe-peck, WHSPP = Walk-halt-scratch-probe-peck.

techniques were observed more frequently in tree-covered and agricultural habitats, suggesting adaptability to varied substrate conditions and food availability,[44] while minimal in barren land, which may be due to lower food density.[45] Similar findings were obtained in red jungle fowl *(Gallus gallus)*, in which the combination of pecking with scratching enhances foraging efficiency.[46] WHP was found to be maximum across all habitat types, which may be due to its energy-efficient nature, allowing birds to visually detect and capture prey across varying substrate conditions with minimal effort.[47]

In this field investigation, WHP appeared dominant foraging technique in both breeding and non-breeding seasons, which might have reflected the accessibility of

Table 1. Foraging success (Mean±S.E.) of grey francolin in different habitat and seasons (2022-2024).

	Agricultural land		Tree-covered land		Shrubland		Barren land	
	Breeding	Non-breeding	Breeding	Non-breeding	Breeding	Non-breeding	Breeding	Non-breeding
Movement rate (steps/minute)	37.24 ± 4.26	35.34 ± 3.79	39.32 ± 5.17	36.08 ± 4.12	35.37 ± 3.65	31.86 ± 2.38	42.56 ± 6.42	37.65 ± 5.29
Feeding rate (pecks/minute)	21.32 ± 3.44	18.87 ± 2.17	22.58 ± 2.82	18.73 ± 1.85	22.84 ± 2.65	18.94 ± 1.12	19.22 ± 2.09	15.36 ± 0.95
Foraging success rate (prey consumed/ minute)	17.56 ± 2.12	15.08 ± 1.75	16.47 ± 1.92	13.15 ± 1.05	19.43 ± 2.25	15.68 ± 1.89	12.36 ± 1.04	9.42 ± 0.83
% of successful attempts	82.37	79.92	72.94	70.21	85.07	82.79	64.32	61.33

surface-active arthropods, seeds, and grains. This study coincided with prior observations reported in other ground-dwelling bird species.[47,48] However, WHPP, WHSP, and WHSPP techniques were also prominent in the breeding season, which may be due to maximum exploitation of the available food items. Our results revealed that the WHP technique was less frequently used in barren land, which may be due to limited surface prey availability, a pattern consistent with findings by English et al.[49]

The WHPP technique was statistically significantly more often used, supporting a previous study that probing enhances access to underground prey.[50] This technique targeted buried food sources such as insect larvae, termites, and underground seeds. In avian species, foraging strategies are specialized to assess the hidden prey within substrates like moss, mud, and bark.[12] However, non-breeding seasonal declines in WHPP usage may be due to lower prey availability because of variation in weather conditions. Similar observations on red jungle fowl have shown how environmental conditions drive seasonal shifts in foraging behaviour.[51]

The WHSP technique showed seasonal variation, with higher utilisation in the breeding season correlated with increased insect intake, which may be due to supplementing reproductive energy demands,[52] and habitat-driven foraging adaptations influence seasonal feeding tactics.[53] The WHSP technique enables birds to access hidden insect larvae and seeds in the ground layer.[54] This observation agrees with earlier field study in Galliformes, where ground scratching is a primary foraging strategy, often used to access buried food sources such as seeds and insect larvae.[54] Seasonal declines in WHSP usage may be due to variation in food resources, drier soil conditions, and compacted leaf litter, influencing the foraging efficiency. Previous research on breeding farmland birds (*Alauda arvensis, Emberiza citronella*, and *Turdus philomelos*) has shown that habitat conditions and resource availability significantly influence foraging behaviour.[55]

WHSPP was the least utilised technique. However, the application of this technique was observed to be more frequent in the breeding season, indicating a necessity for a multi-step foraging to locate buried seeds and insect larvae.[56] Similar patterns have been observed in spotted sandpipers (*Actitis macularius*), energy budgets shift dynamically across reproductive phases to optimise survival and reproductive success.[57]

Table 2. Undigested food parts (Mean ± S.D.) found in grey francolin faeces in breeding and non-breeding season (2022-2024).

		Total fragments	Plant parts	Animal parts	Grit
Season	Month	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.
Breeding	April	11.943 ± 1.206	6.368 ± 0.793	4.271 ± 0.778	1.189 ± 0.452
	May	12.166 ± 2.188	6.638 ± 1.288	4.351 ± 0.793	1.122 ± 0.389
	June	12.627 ± 2.999	6.979 ± 1.311	4.411 ± 1.379	1.189 ± 0.452
	July	13.007 ± 2.598	6.771 ± 1.505	4.832 ± 0.900	1.335 ± 0.515
	August	13.818 ± 2.374	7.555 ± 1.371	4.979 ± 1.084	1.189 ± 0.452
	September	13.388 ± 3.055	7.231 ± 1.371	4.830 ± 1.414	1.189 ± 0.452
Non-breeding	October	12.774 ± 2.937	7.501 ± 1.614	4.111 ± 1.371	1.059 ± 0.289
	November	12.995 ± 2.250	7.738 ± 1.832	3.957 ± 0.603	1.122 ± 0.389
	December	11.976 ± 1.730	7.111 ± 0.937	3.579 ± 0.778	1.189 ± 0.452
	January	12.449 ± 1.929	7.590 ± 1.603	3.529 ± 0.669	1.189 ± 0.452
	February	12.157 ± 1.545	7.191 ± 0.965	3.702 ± 0.622	1.189 ± 0.452
	March	12.693 ± 2.038	7.491 ± 1.240	3.843 ± 0.793	1.260 ± 0.492

Foraging success

Foraging success is considered a primary indicator of food availability and represents a basic component of individual fitness and adaptation to the environment.[58] Several factors, including the availability of food items,[59] and geographical features of the habitat,[60] might have influenced foraging success. The optimal foraging theory states that animals maximise the cost-benefit ratio by selecting the most favourable and efficient habitat patches for foraging.[61]

Our results indicated that the rate of walking had been significantly affected by seasons and habitats in the grey francolin. Previous research on ground-nesting birds indicated that an increase in walking rate corresponds with enhanced prey search efficiency.[47] The highest movement rate was recorded in barren land during the breeding season, which may be attributed to the necessity for extensive searching required by birds to cover greater distances,[7] and the lowest in shrubland during the non-breeding season, which may result from higher food availability in shrubland and lowest in barren land in both the seasons,[29,62] leading to less exploratory movement across habitats.[63]

During the breeding season, grey francolin achieved a peak in the feeding rate, particularly in shrubland. The earlier study has shown that shrubs provide sufficient cover and abundant food resources for foraging birds, which may increase foraging rates by increasing food accessibility and reducing predation danger.[64,65] A similar pattern was observed in egg-laying adult hens (*Gallus gallus domesticus*).[66] The lowest feeding rate occurred in barren land during the non-breeding season. The barren land typically offers sparse vegetation and limited food resources. As winter months represent the majority of the non-breeding season, low temperatures may constrain the resources available, which could affect foraging efficiency.[55,67]

Our results showed that the maximum foraging success rate occurred in the shrubland during the breeding season. Previous studies on ground-foraging pheasants and lapwings suggest that these species prefer shrub-covered and uncultivated areas for more efficient foraging during the breeding season.[47,68] Many aspects, including diet, foraging mode, prey availability, mobility, vigilance rate, habitat type, and weather conditions, might have influenced foraging success in birds.[69] It gives an index of food availability, which is considered the main determinant of clutch size, reproductive success, and timing of the breeding season.[70] The results indicated a lowest foraging success rate in barren land may be due to reduced prey density, high predation risk, and increased energetic costs of searching in the non-breeding season.[71,72] Under conditions of food scarcity, both foraging cost and resource availability likely influenced the selection of foraging sites.[73] However, birds may select a habitat to forage, where they achieve the greatest foraging success.[74]

Diet

Our faecal analysis results have shown various food items, including plant and animal, and grit. The plant material might have consisted of seeds, leaves, fruits, and tubers, while the animal matter included various arthropods such as ants, termites, beetles, and their larvae. In faecal analysis, plant-derived parts such as epidermis, cuticle, trichome, and fragments of fruit coats and seed coats were commonly identified, whereas arthropod remains were represented by chitinous structures, including mouthparts, abdominal segments, elytra, mandibles, heads, thorax, wing fragments, antennae, and leg fragments.[41,42] We did not identify them up to the species level.

Our results showed that plant material was consumed less during the breeding season. These findings are similar to those of previous studies on different species of ground-dwelling pheasants, including grey partridges (*Perdix perdix*),[75] chukars (*Alectoris chukar*), and sand partridges (*Ammoperdix heyi*).[76] In a nutshell, the diet predominantly consisted of plant matter, reflecting a shift towards a more vegetation-based nutrition due to reduced energy requirements[77] and seasonal plant availability during the breeding season.[78] The reduction in insect intake reflected lower metabolic demands[76] in post-breeding and reduced prey availability in winter months.[79]

Results suggested that animal matter consumption increased progressively in the breeding season compared to the non-breeding season. This finding coincides with earlier studies on the diet of black francolin (*Francolinus francolinus henrici*).[24] The presence of diverse chitinous remains, mandibles, elytra, thorax, and leg fragments in faecal samples confirms active predation and dietary selectivity.[21] The developmental stages of birds demand high-protein diets.[80] Insects, being rich in protein, essential amino acids, and fats, provide the necessary nutrients that contribute to embryo development, growth acceleration, and feather formation in young birds.[81]

The presence of grit in both seasons, with a non-significant difference, indicates its consistent role in assisting mechanical digestion, particularly of fibrous plant material and chitinous insect remains. Our findings are similar to those of previous studies on other francolin species.[82] Grit plays a crucial role in grinding harder food particles within the crops of birds, as food is ingested directly without mastication due to the absence of teeth in the buccal cavity.[24]

In conclusion, we found no significant variation in foraging techniques across all habitat types; however, Walk-halt-peck (WHP) appeared to be the most utilized one. Notably, foraging success varied significantly across habitats and seasons, with a higher rate during the breeding season, particularly in shrubland. Diet analysis revealed seasonal shifts with significant differences in plant and animal matter during the breeding season, while grit content remained consistent across seasons. These findings partially support our hypothesis, indicating consistent foraging technique but varying foraging success and dietary breadth, suggesting a seasonally adaptive yet generalist feeding strategy.

Our study highlights the ecological flexibility of the grey francolin through its adaptive foraging behaviour and dietary shifts. Seasonal sampling was restricted to two broad seasons (breeding and non-breeding), potentially overlooking finer temporal variations in diet and foraging behaviour. Finally, the study was geographically confined to a single region, which may limit generalizability across the species' broader distribution range. Future research should incorporate molecular diet profiling, prey availability surveys, and broader spatial sampling to enhance ecological generalizability. The species' reliance on insect-rich diets and habitat-specific foraging success emphasizes its role in ecosystem functioning and the importance of conserving structurally diverse habitats. These insights offer valuable guidance for managing agro-ecological landscapes to support ground-dwelling avifauna.

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Author contributions

AM: Conceptualisation, field survey, data collection, statistical analysis, and writing. HM: Interpretation. VK: Interpretation. Prateek: Data collection and interpretation. AK: Conceptualisation, research planning, and interpretation.

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Declaration of conflicting interests

The authors have no further conflicts of interest to declare.

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