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Bird composition, diversity and foraging guilds in agricultural landscapes: a case study from eastern Uttar Pradesh, India

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Abstract: Birds have a significant role in maintaining the ecological balance of agro-ecosystems. But yet there is no documentation related to bird diversity in the agricultural landscapes of eastern Uttar Pradesh. This study was conducted from March 2019 to February 2020 using fixed radius point count method in Ayodhya district of eastern Uttar Pradesh. A total of 139 bird species belonging to 107 genera, 49 families and 15 orders were recorded from the study area. Passeriformes was the most dominant order with 28 families and 76 species. Accipitridae and Muscicapidae were the most diverse families with 11 species each and RDi value of 7.91. Among the recorded bird species, 105 species (76%) were resident, 29 species (21%) were winter visitors and only 5 species (4%) were summer visitors. According to the feeding guilds, omnivores (46 species, 33%) were highly represented, followed by insectivores (31%), carnivores (25%), granivores (6%), frugivores (4%) and nectarivores (1%). The Sohawal tehsil was found to have the highest species richness and a Shannon-Weiner diversity index (133, 4.30). *Aquila nipalensis* and *Neophron percnopterus* were the two 'Endangered' species, *Antigone antigone* and *Clanga hastata* were the two 'Vulnerable' species and *Ciconia episcopus*, *Gyps himalayensis, Mycteria leucocephala* and *Psittacula eupatria* were the four 'Near Threatened' species found in this region. In addition to this, the region also supported 31 species (22%) whose global population trend is decreasing. This study provides a baseline data on the bird diversity present in agricultural landscapes of this region. Based on which further studies should be designed to understand the factors influencing the diversity of birds in these agricultural landscapes which are continuously subjected to anthropogenic pressures.

Keywords: Ayodhya, Avifauna checklist, community parameters, feeding guilds, relative diversity, species richness.

Hindi: पारिस्थितिकी तंत्र के पारिस्थितिक संतुलन को बनाए रखने में पक्षियों की महत्वपूर्ण भूमिका होती है लेकिन अभी तक पूर्वी उत्तर प्रदेश के कृषि परिदृश्य में पक्षी विविधता से संबंधित कोई भी शोध उपलब्ध नहीं है। यह अध्ययन पूर्वी उत्तर प्रदेश के अयोध्या जिले में निश्चित त्रिज्या बिंदु गणना पद्धति का उपयोग करके मार्च 2019 से फरवरी 2020 तक आयोजित किया गया था। अध्ययन क्षेत्र से 107 वंशो 49 कुलों 15 गणो से संबंधित कुल 139 पक्षी प्रजातियों को दर्ज किया गया था। 28 कुलों और 76 प्रजातियों के साथ पैसेरीफार्मिस सबसे प्रमुख गण था, एस्सीपिट्रीडी और मस्सीकैपिडी सबसे अधिक विविधता वाले कुल थे जिनमें से प्रत्येक में 11 प्रजातियां थी और आरडीआई मान 7.91 था। दर्ज की गई पक्षी प्रजातियों में 105 प्रजातियां स्थानीय थी 21% प्रजातियां शीतकालीन आगंतुक थी और केवल 5 प्रजातियां विषम कालीन आगंतुक थी। फीडिंग गिल्ड के अनुसार 40 प्रजातियां सर्वाहारी थी इसके बाद 21% कीटभक्षी, 25% मांसाहारी, 6% दानाभक्षी, 4% फलभक्षी और 1% मकरंद आहारी थी। सोहावल तहसील में उच्चतम प्रजाति समृद्धि और शैनन विनर विविधता सूचकांक (133,4.30) पाया गया। एक्विला निपालेंसिस और नियोफ्रान पक्नोप्टेरस दो संकटग्रस्त प्रजातियां थी, एंटीगोन और क्लैंगा हस्तटा दो सुभेद्य (वलनेरेबरल) प्रजातियां थी और सिकानिया एपिस्कोपस, जिप्स हिमालयेंसिस, माक्टेरिया ल्यूकोसेफला और सिटाकुला यूपेट्रिया चार संभावित संकटग्रस्त प्रजातियां थी जो इस क्षेत्र में पाई जाती है। इसके अलावा इस क्षेत्र में पाई जाने वाली प्रजातियों में से ३१ प्रजाति ऐसी भी थीं जिनकी वैश्विक जनसंख्या लगातार कम हो रही है। यह अध्ययन कृषि परिदृश्य में पक्षियों की विविधता को समझने के लिए भविष्य के अनुसंधानो के लिए एक महत्वपूर्ण साधन साबित हो सकता है, विशेषकर उन क्षेत्रों के लिए जो मानव जनित दबावों का सामना कर रहे हैं।

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For **Author details** and **Author contributions** see end of this article

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INTRODUCTION

Agriculture is the most dominant land use in the tropical and sub-tropical regions of the world. In India, nearly 60.45% of the total land is under agriculture (Anonymous 2021a). Even if the area under protected area is as small as 15.40% globally (Anonymous 2021b) and 5.00% (Anonymous 2021c) in India, the conservationists have always concentrated on natural forests or protected areas for species conservation. But lately, the focus has been slowly changing to conservation outside protected areas. Recent studies have highlighted the importance of human-dominated agroforestry systems and agricultural landscapes in conservation of common to globally concerned vertebrates and invertebrates (Athreya et al. 2010; Sundar & Subramanya 2010). Birds play a vital role in maintaining the ecological balance in agro-ecosystems (Haslem & Bennett 2008). An agricultural system provides food like grains, seeds, fruits, green vegetation, plants, grasses, insects, arthropods and rodents to the birds (O'Connor & Shrubb 1986; Asokan et al. 2009). Birds, therefore, play a dual role of pests by feeding on grains and seeds as well as of bio-control agents by feeding on insect pests of agricultural crops (Borad et al. 2000). Thus, they act as both friend and foe of farmers. In addition to this, birds also have functional roles of seed dispersal, pollination, scavenging, nutrient deposition etc. (Dhindsa & Saini 1994; Whelan et al. 2008; Sekercioglu 2012) making them beneficial to nature and thus humans. The occurrence of birds in agricultural systems is influenced by many factors such as the crop type, structural complexity, i.e., vertical stratification formed by the grasses, shrubs and trees, type of management and landscape composition (Taft & Haig 2006; Bruggisser et al. 2010; Wretenberg et al. 2010). Most of the agricultural lands are intermingled with agroforestry & horticultural trees, wetlands, remnant vegetation, natural forest fragments, grasslands and poultry farms influencing the bird diversity positively.

Uttar Pradesh is the top most producer of food grains in the country and also is one of the most intensively cultivated regions of the world (Ramankutty & Foley 1998). This State has undergone various developments and mechanizations in its farming systems due to rapid urbanization and industrialization. Some of them include excessive use of pesticides and fertilizers, intensive agriculture, very good network of irrigation etc. which have altered the agro-ecosystems as well as the bird composition. Some studies show evidences that the existence of birds in agricultural lands depends on low-intensity agricultural practices (Doxa et al. 2010). To study the impacts of agricultural mechanization on birds, it is important to first record the bird diversity present in this most dominant land use system of Uttar Pradesh. It is also important that the birds which act as bio-control agents and bio-indicators of the agro-ecosystems should be conserved in these landscapes. This study, therefore, aims to produce a checklist of birds associated with agricultural fields which can then be further used as a baseline for detailed investigation and research.

The avian diversity in agricultural landscapes has been studied by different authors in different states of India. Work has been done on bird composition and diversity in the agricultural fields of Punjab (Malhi 2006), Karnataka (Basavarajappa 2006), Maharashtra (Abdar 2014), West Bengal (Hossain & Aditya 2016), Uttarakhand (Elsen et al. 2016), Odisha (Mukhopadhyay & Mazumdar 2017), Telangana (Narayana et al. 2019) and Haryana (Kumar & Sahu 2020). Studies have also been conducted on bird diversity in paddy fields (Borad et al. 2000; Jayasimhan & Pramod 2019). Sundar (2006, 2009), Sundar & Subramanya (2010), Sundar & Kittur (2012, 2013) have studied bird composition in agricultural fields and their use by birds in western Uttar Pradesh. Studies have also been undertaken on bird diversity in wetlands and bird sanctuaries (Kumar & Kanaujia 2016; Mishra et al. 2020), and protected areas (Javed & Rahmani 1998; Iqubal et al. 2003, Khan et al. 2013) in Uttar Pradesh. However, there has been no study on the bird diversity in agricultural landscapes of eastern Uttar Pradesh. In this context, the present study is designed to document the bird species composition and diversity in the agricultural landscapes of Ayodhya district, eastern Uttar Pradesh.

MATERIALS AND METHODS

Study area

This study was conducted in five tehsils namely, Sohawal, Rudauli, Milkipur, Sadar and Bikapur of Ayodhya district, eastern Uttar Pradesh (Figure 1). The details of each tehsil are given in Table 1. Two study sites were chosen in each tehsil (Figure 1). Ayodhya district is situated between 26.7730 °N and 82.1458 °E. It has an elevation of 93 m above mean sea level and has an area of 2,764 km^2 (Anonymous 2021d). The net cultivated area in the district is 1,710 km^2 and the total forest area is 3,038 km^2 (Anonymous 2021d). The city of Ayodhya is situated on the banks of the river Saryu. The climate is humid subtropical (Kumar 2018) experiencing three major seasons, i.e., summers (March to June), rainy (July to October) and winters (November to February) (Sundar

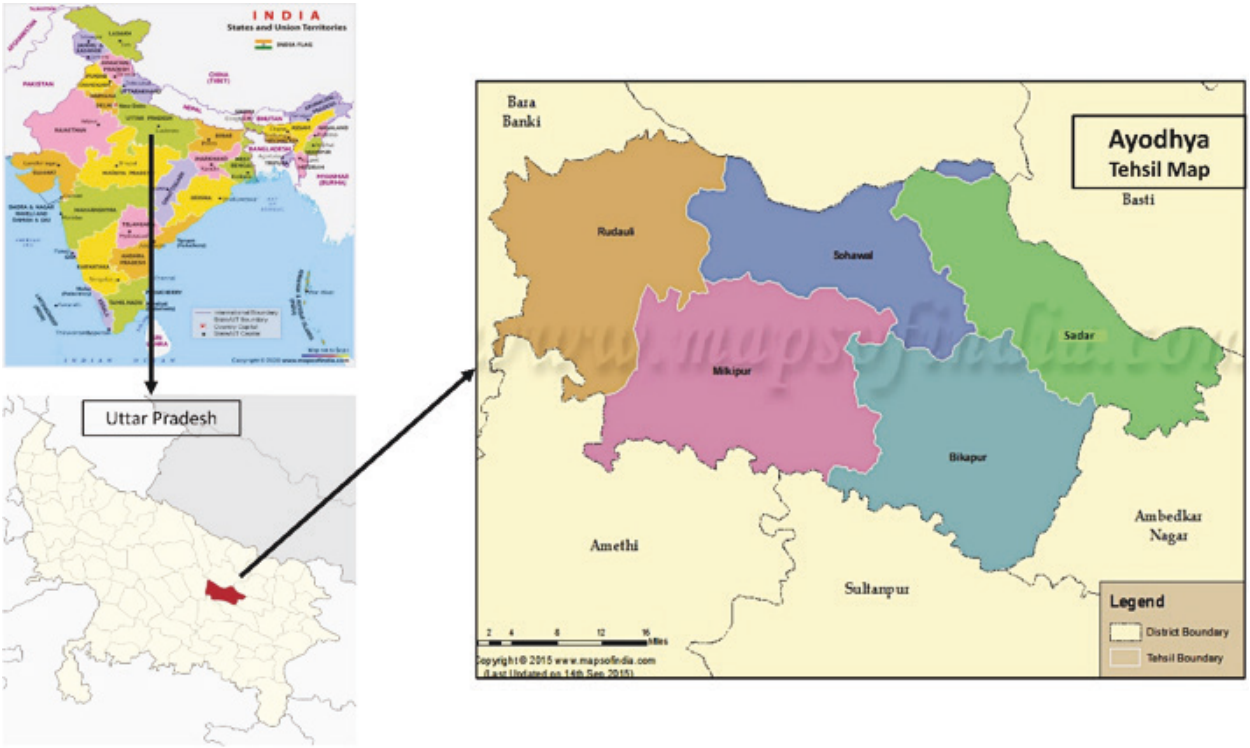

Figure 1. The study area and locations of selected agricultural landscapes of Ayodhya district, eastern Uttar Pradesh, India.

& Kittur 2012). The district receives annual rainfall of 1,067 mm. The average temperature during summers is 32 ^{0}C and in winters is 16 ^{0}C (Anonymous 2021d). The area also experiences heat and cold waves at times (Kumar 2018). The topography of the district is plain. The soil varies from clay soil to sandy soil across the district and is suitable for raising horticultural and agricultural crops. Agriculture is dependent on rain, tube-wells and canals for irrigation. This region is inhabited by small, marginal and landless farmers. The main cropping system of the area is rice-wheat cropping system (Anonymous 2021d). *Saccharum officinarum* is the main cash crop grown which serves as the raw material for the jaggery and sugar industries in Sadar tehsil. Apart from this, crops like *Cajanus cajan, Vigna mungo, Vigna radiata, Cicer arietinum, Sorghum bicolor, Zea mays, Hordeum vulgare, Brassica* sp., vegetable (e.g., *Solanum tuberosum*), fruit crops (*Mangifera indica, Psidium guajava*) and fodder crops are also grown (Anonymous 2021d).

Method

In each tehsil, two sites were selected randomly. Bird surveys were conducted using fixed radius, point-count method (Bibby et al. 2000) in selected sites on a monthly basis between 0600h to 0830h from March 2019 to February 2020. In every tehsil, a transect of 1 km in length was laid in each of the two sites and five permanent point counts were marked at every 250 m distance on each transect. So, in each tehsil 10 point counts were marked, making a total of 50 point counts in Ayodhya district. The birds were recorded in 30 m radius from the point count. At every point count, a five minutes settling down time was given before recording the birds. Species were recorded for 10 minutes at every point count. Each point count was surveyed 24 times during the entire study period. Birds were recorded directly using a pair of field binoculars (Nikon 7x35). On sighting the birds, the species name, number of individuals and habitat were recorded. Birds flying across were not counted. The opportunistic counts during the other time of the day were also included. Bird identification was done following Grimmett et al. (2011). Praveen et al. (2020) was followed for the taxonomic position (order and family), common names and scientific names of species observed. According to the observations made in the field and following Ali & Ripley (1987), the species were also classified into six major feeding guilds, i.e., insectivorous (feeds exclusively on insects), carnivorous (feeds mainly on non-insect invertebrates and vertebrates), granivorous (feeds mainly on grains/seeds), frugivorous (feeds mainly on fruits), nectarivores (feeds mainly on nectar) and omnivorous (feeds on both plant and animal

parts). The IUCN Red List (2021) was followed to compile the global population trend (decreasing, increasing, stable, unknown) of the recorded species.

Species richness was calculated as total number of bird species recorded in the study area.

The following community parameters were calculated using the below given formulae at each tehsil:

[i] Relative diversity of bird families (RDi) (Torre-Cuadros et al. 2007)

$$RDi = \frac{\text{Number of bird species in a family}}{\text{Total number of species}} \times 100$$

[ii] Shannon Weiner index (Shannon & Weiner 1963)

$$H' = \Sigma^{s}_{i=1} p_i \ln p_i$$

where, p_i is often the proportion of individuals belonging to the 'i'th species in the dataset and 's' is the species richness. The values usually lies between 1 and 4 where 1 shows less diversity and 4 shows high diversity.

[iii] Simpson's index (Simpson 1949)

This was calculated according to Simpson (1949) to measure the concentration of dominance (CD) of bird species.

$$CD = \Sigma^{s}_{i=1} (p_i)^2$$

where pi is the proportion of the IVI of the 'i'th species and IVI of all the species (ni/N). The values of Simpson's index is limited to 1 where 1 shows dominance by a single species.

[iv] Pielou's evenness index (Pielou 1966)=H'/ $\log_{10}$N(S)

where H' is the Shanon Weiner diversity index and 'S' is the total number of species. This index ranges from 0 (no evenness) to 1 (complete evenness).

[v] Sorenson's similarity coefficient (Sorenson 1948)

$$\text{Sorenson similarity coefficient} = \frac{2C}{A+B}$$

where C is the number of species common to both sites, A is the total number of species in site A and B is the total number of species in site B. Sorenson's coefficient gives a value between 0 and 1, the closer the value is to 1, the more the communities have in common.

RESULTS

A total of 139 species of birds belonging to 107 genera, 49 families and 15 orders were recorded from the study area (Table 2). Passeriformes was the most dominant order with 28 families and 76 species followed by Accipitriformes (1 family and 11 species) (Figure 2). Falconiformes and Bucerotiformes were the least dominant orders with one family and one species each (Figure 2). According to the residential status of the birds, 105 bird species (76%) were resident, 29 bird species (21%) were winter visitors and only 5 bird species (4%) were summer visitors (Figure 3). As far as the feeding guilds were concerned, six foraging guilds were found in the study area. Omnivores (46 species, 33%) were highly represented, followed by insectivores (31%) whereas, nectarivores (1 species, 1%) was the least represented guild (Figure 4).

Accipitridae and Muscicapidae were the most diverse families (11 species each, RDi= 7.91), followed by Ardeidae, Columbidae and Cuculidae (7 species each, RDi= 5.04). On the other hand, 18 families namely, Aegithinidae, Bucerotidae, Coraciidae, Dicaeidae, Dicruridae, Falconidae, Glareolidae, Gruidae, Monarchidae, Nectariniidae, Paridae, Rallidae, Sittidae, Stenostiridae, Turdidae, Upupidae, Vangidae & Zosteripidae were least represented (1 species each, RDi= 0.72) (Table 3).

Sohawal tehsil had the highest species richness and Shannon-Weiner diversity index (133, 4.30), followed by Rudauli (126, 4.28), Milkipur (119, 4.25) and Bikapur (114, 4.23) (Table 4). Whereas the lowest species richness and Shannon-Weiner diversity index was found in Sadar (98, 3.86) (Table 4). The Simpson's Dominance index indicated that all sites were highly diverse in terms of bird species and no single bird species was dominant (Table 4). The Pielou's Evenness index was the highest in Bikapur (0.89), followed by Rudauli and Milkipur (0.88 each), Sohawal (0.87) and the lowest in Sadar (0.84). This index highlighted that the bird communities in each tehsil was nearly even i.e. all the species were equally represented (Table 4). The Sorenson's Similarity index indicated that all the sites were almost similar in diversity (Table 5). The highest similarity existed between the sites of Rudauli and Milkipur (0.94), followed by Sohawal and Rudauli (0.93) and the lowest similarity existed between the sites of Sohawal and Sadar (0.82) (Table 5).

Of the 139 species recorded, two species (1.44%) were 'Endangered', two species (1.44%) were 'Vulnerable', four species (2.88%) were 'Near Threatened' and the rest (131 species, 94.24%) were 'Least Concern' according to the IUCN Red List (Table 2). With regard to the global population trend, this area supported 66 globally stable bird species (48%), 31 globally decreasing species (22%), 28 globally increasing species (20%) and 14 species (10%) whose global population trend was unknown (Figure 5). In addition to this, 15 species recorded from this area were listed in Appendix II of CITES and one species was under Appendix III of CITES (Table 2). According to the

Table 1. General characteristics of the selected agricultural landscapes in Ayodhya District, eastern Uttar Pradesh, India.

Name of tehsil	Co-ordinates	Features
Sohawal	26.694°N, 81.974°E	Rice-wheat cropping system along with mustard and sugarcane dominates in the area. The area has orchards of *Mangifera indica.* Trees of *Eucalyptus* sp. and *Tectona grandis* are planted on the field boundaries in agroforestry systems. The area has large to small sized wetlands. The main source of water is the tube wells.
Rudauli	26.698°N, 81.611°E	Rice-wheat is the major cropping system in this area. Mustard, vegetables, fruits are also grown in this area. The study area is adjacent to Rudauli Forest Reserve. Apart from this, the area has orchards and agroforestry systems in which *Eucalyptus* sp. is planted on the boundaries of the fields. It has very few small sized water bodies. Agricultural activities are dependent upon tube wells.
Milkipur	26.632°N, 81.910°E	Wheat, mustard, sugarcane, rice, bajra are grown in this area. This area has good patches of tall wooded trees, plantations, orchards, agroforestry systems, grasses and wetlands. The irrigation is done through canals and tube wells.
Bikapur	26.616°N, 82.194°E	Wheat, mustard and rice are the major crops grown in this area. There are some orchards and few small sized water bodies available in this area. Tube wells are used for irrigation purpose.
Sadar	26.793°N, 82.158°E	Wheat, rice and sugarcane are the major crops grown in this area. There are many jaggery and sugar industries located in this area. There are some orchards and wetlands available in this area. This area is mostly influenced by urbanization.

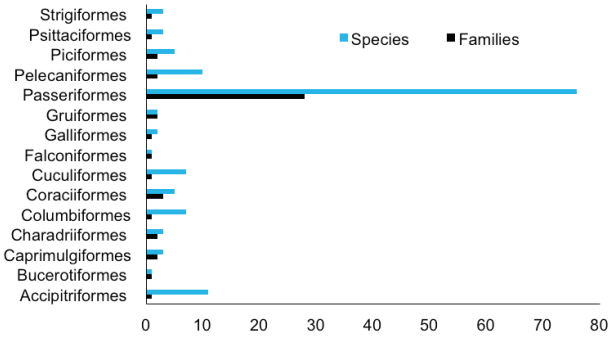

Figure 2. Composition of avian community in selected agricultural landscapes of Ayodhya district, eastern Uttar Pradesh, India.

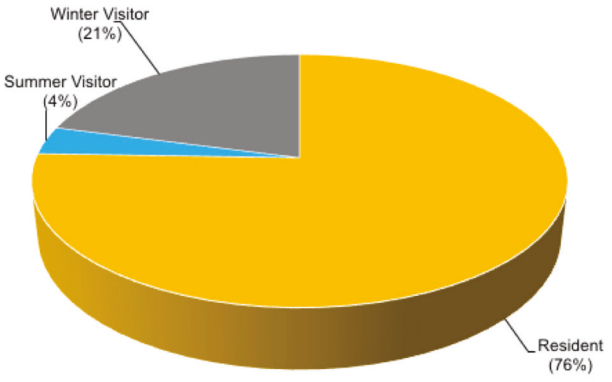

Figure 3. Seasonal status of avian species recorded from agricultural landscapes of Ayodhya district, eastern Uttar Pradesh, India.

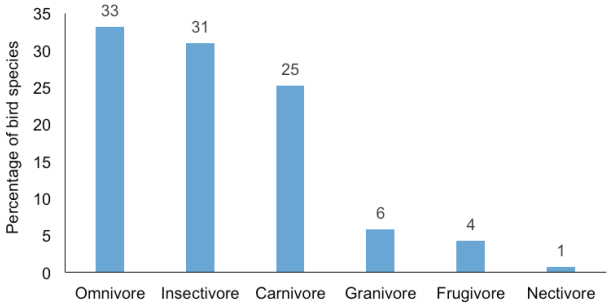

Figure 4 Guild-based classification of avian species recorded in agricultural landscapes of Ayodhya district, eastern Uttar Pradesh, India.

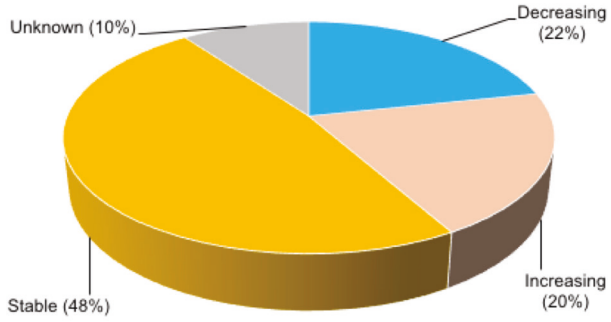

Figure 5. Comparison of global status of avifaunal species recorded in selected agricultural landscapes of Ayodhya district, eastern Uttar Pradesh, India.

IWPA (1972), out of 139 species, 11 species were under Schedule I, one species was in Schedule V and the rest were in Schedule IV (Table 2).

DISCUSSION

Agricultural landscape is the preferred habitat for 45% of the birds of the Indian subcontinent (Sundar & Subramanya 2010), however some species are known to visit this landscape only occasionally (Sekercioglu et al. 2012). This might be one of the reasons for finding 139 bird species in the agricultural landscapes of Ayodhya

Table 2. Checklist and status of avifauna recorded in agricultural landscapes of Ayodhya district, eastern Uttar Pradesh, India.

	Order/Family/Common name	Scientific name	Residential status	Feeding status	Conservation status			Global status	Sites					Image No.
					IUCN (2021)	CITES (2012)	IWPA (1972)		SHW	RDL	MKP	BKP	SDR	
Accipitriformes Accipitridae (11)														
1	Black Kite	*Milvus migrans* (Boddaert, 1783)	R	C	LC	II	I	→	√	√	√	√	√	
2	Black-winged Kite	*Elanus caeruleus* (Desfontaines, 1789)	R	C	LC	II	I	→	√	√	√	√	√	
3	Crested Serpent Eagle	*Spilornis cheela* (Latham, 1790)	R	C	LC	-	IV	→	√	√	√	√	×	2g
4	Egyptian Vulture	*Neophron percnopterus* (Linnaeus, 1758)	R	C	EN	-	I	↓	√	√	√	√	√	2c
5	Himalayan Vulture	*Gyps himalayensis* (Hume, 1869)	WV	C	NT	II	I	→	×	×	√	√	×	
6	Indian Spotted Eagle	*Clanga hastata* (Lesson, 1831)	R	C	VU	II	I	↓	√	√	√	√	√	
7	Shikra	*Accipiter badius* (Gmelin, 1788)	R	C	LC	II	I	→	√	√	√	√	√	2h
8	Short-toed Snake Eagle	*Circaetus gallicus* (Gmelin, 1788)	R	C	LC	II	I	→	√	√	√	√	×	
9	Steppe Eagle	*Aquila nipalensis* (Hodgson, 1833)	WV	C	EN	II	I	↓	√	×	×	√	×	
10	Western Marsh-harrier	*Circus aeruginosus* (Linnaeus, 1758)	WV	C	LC	II	I	↑	√	√	√	×	×	
11	White-eyed Buzzard	*Butastur teesa* (Franklin, 1831)	R	C	LC	II	I	→	√	√	√	√	√	
Bucerotiformes Bucerotidae (1)														
12	Indian Grey Hornbill	*Ocyceros birostris* (Scopoli, 1786)	R	O	LC	-	IV	→	√	√	×	√	√	
Caprimulgiformes Apodidae (2)														
13	Asian Palm Swift	*Cypsiurus balasiensis* (Gray, 1829)	R	I	LC	-	IV	→	√	√	√	√	√	
14	Indian House Swift	*Apus affinis* (Gray, 1830)	R	I	LC	-	IV	↑	×	√	×	×	×	
Upupidae (1)														
15	Common Hoopoe	*Upupa epops* (Linnaeus, 1758)	R	O	LC	-	IV	↓	√	√	√	√	√	1c
Charadriiformes Charadriidae (2)														
16	Red-wattled Lapwing	*Vanellus indicus* (Boddaert, 1783)	R	O	LC	-	IV	?	√	√	√	√	√	
17	Yellow-wattled Lapwing	*Vanellus malabaricus* (Boddaert, 1783)	R	C	LC	-	IV	→	√	√	√	×	×	
Glareolidae (1)														
18	Small Pratincole	*Glareola lactea* (Temminck, 1820)	R	I	LC	-	IV	?	√	√	√	√	√	
Columbiformes Columbidae (7)														
19	Eurasian Collared Dove	*Streptopelia decaocto* (Frivaldszky, 1838)	R	G	LC	-	IV	↑	√	√	√	√	√	

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					IUCN (2021)	CITES (2012)	IWPA (1972)		SHW	RDL	MKP	BKP	SDR	
20	Laughing Dove	*Streptopelia senegalensis* (Linnaeus, 1766)	R	G	LC	-	IV	→	√	√	√	√	√	
21	Oriental Turtle Dove	*Streptopelia orientalis* (Latham, 1790)	WV	G	LC	-	IV	→	√	√	√	×	√	
22	Red Collared Dove	*Streptopelia tranquebarica* (Hermann, 1804)	R	G	LC	-	IV	↓	√	√	√	√	√	
23	Rock Pigeon	*Columba livia* (Gmelin, 1789)	R	G	LC	-	IV	↓	√	√	√	√	√	
24	Spotted Dove	*Streptopelia chinensis* (Scopoli, 1786)	R	G	LC	-	IV	↑	√	√	√	√	√	
25	Yellow-footed Green Pigeon	*Treron phoenicopterus* (Latham, 1790)	R	F	LC	-	IV	↑	√	√	√	√	√	2e
Coraciiformes Alcedinidae (2)														
26	Common Kingfisher	*Alcedo atthis* (Linnaeus, 1758)	R	C	LC	-	IV	?	√	√	√	√	√	2b
27	White-throated Kingfisher	*Halcyon smyrnensis* (Linnaeus, 1758)	R	C	LC	-	IV	↑	√	√	√	√	√	1a
Coraciidae (1)														
28	Indian Roller	*Coracias benghalensis* (Linnaeus, 1758)	R	C	LC	-	IV	↑	√	√	√	√	√	
Meropidae (2)														
29	Blue-tailed Bee-eater	*Merops philippinus* (Linnaeus, 1767)	SV	I	LC	-	IV	→	√	√	√	√		
30	Green Bee-eater	*Merops orientalis* (Latham, 1801)	R	I	LC	-	IV	↑	√	√	√	√		
Cuculiformes Cuculidae (7)														
31	Asian Koel	*Eudynamys scolopaceus* (Linnaeus, 1758)	R	O	LC	-	IV	→	√	√	√	√	√	
32	Common Hawk Cuckoo	*Hierococcyx varius* (Vahl, 1797)	R	O	LC	-	IV	→	√	√	√	√	×	
33	Greater Coucal	*Centropus sinensis* (Stephens, 1815)	R	O	LC	-	IV	→	√	√	√	√	√	
34	Grey-bellied Cuckoo	*Cacomantis passerinus* (Vahl, 1797)	SV	I	LC	-	IV	→	√	×	×	×	×	
35	Indian Cuckoo	*Cuculus micropterus* (Gould, 1838)	SV	O	LC	-	IV	↓	√	√	√	×	×	
36	Pied Cuckoo	*Clamator jacobinus* (Boddaert, 1783)	SV	O	LC	-	IV	→	√	√	√	√	×	
37	Sirkeer Malkoha	*Taccocua leschenaultii* (Lesson, 1830)	R	O	LC	-	IV	→	√	×	×	×	×	
Falconiformes Falconidae (1)														
38	Common Kestrel	*Falco tinnunculus* (Linnaeus, 1758)	WV	C	LC	II	IV	↓	√	√	√	√	√	
Galliformes Phasianidae (2)														
39	Grey Francolin	*Francolinus pondicerianus* (Gmelin, 1789)	R	O	LC	-	IV	→	√	√	√	√	√	
40	Indian Peafowl	*Pavo cristatus* (Linnaeus, 1758)	R	O	LC	III	I	→	√	√	√	√	√	

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Gruiformes Gruidae (1)														
41	Sarus Crane	*Antigone antigone* (Linnaeus, 1758)	R	O	VU	-	IV	↓	√	√	√	√	×	1h
Rallidae (1)														
42	White-breasted Waterhen	*Amaurornis phoenicurus* (Pennant, 1769)	R	O	LC	-	IV	?	√	√	√	√	√	
Passeriformes Acrocephalidae (2)														
43	Blyth's Reed Warbler	*Acrocephalus dumetorum* (Blyth, 1849)	WV	O	LC	-	IV	↑	×	√	√	×	×	
44	Booted Warbler	*Iduna caligata* (Lichtenstein, 1823)	WV	I	LC	-	IV	↑	×	×	×	×	√	
Aegithinidae (1)														
45	Common Iora	*Aegithina tiphia* (Linnaeus, 1758)	R	O	LC	-	IV	?	√	√	√	√	√	
Alaudidae (4)														
46	Ashy-crowned Sparrow-Lark	*Eremopterix griseus* (Scopoli, 1786)	R	O	LC	-	IV	→	√	√	√	√	√	
47	Bengal Bushlark	*Mirafra assamica* (Horsfield, 1840)	R	O	LC	-	IV	→	√	√	√	√	√	
48	Crested Lark	*Galerida cristata* (Linnaeus, 1758)	R	O	LC	-	IV	↓	√	√	√	√	√	
49	Sand Lark	*Alaudala raytal* (Blyth, 1845)	R	O	LC	-	IV	→	√	√	√	√	×	
Campephagidae (3)														
50	Large Cuckooshrike	*Coracina macei* (Lesson, 1831)	R	I	LC	-	IV	↓	√	×	×	×	×	
51	Long-tailed Minivet	*Pericrocotus ethologus* (Bangs & Phillips, 1914)	WV	I	LC	-	IV	↓	√	√	×	×	√	
52	Small Minivet	*Pericrocotus cinnamomeus* (Linnaeus, 1766)	R	I	LC	-	IV	→	√	√	√	√	×	
Cisticolidae (4)														
53	Ashy Prinia	*Prinia socialis* (Sykes, 1832)	R	I	LC	-	IV	→	√	√	√	√	√	
54	Common Tailorbird	*Orthotomus sutorius* (Pennant, 1769)	R	I	LC	-	IV	→	√	√	√	√	√	
55	Plain Prinia	*Prinia inornata* (Sykes, 1832)	R	I	LC	-	IV	→	√	√	√	√	√	1b
56	Zitting Cisticola	*Cisticola juncidis* (Rafinesque, 1810)	R	I	LC	-	IV	↑	√	√	√	√	√	
Corvidae (3)														
57	House Crow	*Corvus splendens* (Vieillot, 1817)	R	O	LC	-	V	→	√	√	√	√	√	
58	Large-billed Crow	*Corvus macrorhynchos* (Wagler, 1827)	R	O	LC	-	IV	→	√	√	√	√	√	
59	Rufous Treepie	*Dendrocitta vagabunda* (Latham, 1790)	R	O	LC	-	IV	↓	√	√	√	√	√	
Dicaeidae (1)														

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					IUCN (2021)	CITES (2012)	IWPA (1972)		SHW	RDL	MKP	BKP	SDR	
60	Thick-billed Flowerpecker	*Dicaeum agile* (Tickell, 1833)	R	O	LC	-	IV	→	√	√	√	√	√	
Dicruridae (1)														
61	Black Drongo	*Dicrurus macrocercus* (Vieillot, 1817)	R	C	LC	-	IV	?	√	√	√	√	√	1d
Estrildidae (3)														
62	Indian Silverbill	*Euodice malabarica* (Linnaeus, 1758)	R	G	LC	-	IV	→	√	√	√	√	√	
63	Red Munia	*Amandava amandava* (Linnaeus, 1758)	R	O	LC	-	IV	→	√	√	√	√	√	
64	Scaly-breasted Munia	*Lonchura punctulata* (Linnaeus, 1758)	R	O	LC	-	IV	→	√	√	√	√	√	
Hirundinidae (5)														
65	Barn Swallow	*Hirundo rustica* (Linnaeus, 1758)	WV	I	LC	-	IV	↓	√	√	√	√	√	
66	Plain Martin	*Riparia paludicola* (Vieillot, 1817)	R	I	LC	-	IV	↓	√	√	√	×	√	
67	Red-rumped Swallow	*Cecropis daurica* (Laxmann, 1769)	R	I	LC	-	IV	→	√	√	√	√	√	
68	Streak-throated Swallow	*Petrochelidon fluvicola* (Blyth, 1855)	R	I	LC	-	IV	↑	√	√	√	√	√	
69	Wire-tailed Swallow	*Hirundo smithii* (Leach, 1818)	R	I	LC	-	IV	↑	√	√	√	√	√	
Laniidae (3)														
70	Bay-backed Shrike	*Lanius vittatus* (Valenciennes, 1826)	R	C	LC	-	IV	→	√	√	√	√	√	
71	Brown Shrike	*Lanius cristatus* (Linnaeus, 1758)	WV	C	LC	-	IV	↓	√	×	×	×	×	
72	Long-tailed Shrike	*Lanius schach* (Linnaeus, 1758)	R	C	LC	-	IV	?	√	√	√	√	√	
Leiothrichidae (3)														
73	Common Babbler	*Argya caudata* (Dumont, 1823)	R	O	LC	-	IV	→	√	√	√	√	√	
74	Jungle Babbler	*Argya striata* (Dumont, 1823)	R	O	LC	-	IV	→	√	√	√	√	√	
75	Striated Babbler	*Argya earlei* (Blyth, 1844)	R	O	LC	-	IV	↓	√	√	×	√	√	
Monarchidae (1)														
76	Indian Paradise-flycatcher	*Terpsiphone paradisi* (Linnaeus, 1758)	SV	I	LC	-	IV	→	√	√	√	×	×	
Motacillidae (6)														
77	Citrine Wagtail	*Motacilla citreola* (Pallas, 1776)	WV	I	LC	-	IV	↑	√	√	√	√	×	
78	Grey Wagtail	*Motacilla cinerea* (Tunstall, 1771)	WV	I	LC	-	IV	→	√	√	×	√	×	
79	Paddyfield Pipit	*Anthus rufulus* (Vieillot, 1818)	R	C	LC	-	IV	→	√	√	√	√	√	
80	Western Yellow Wagtail	*Motacilla flava* (Linnaeus, 1758)	WV	I	LC	-	IV	↓	√	√	×	√	×	
81	White Wagtail	*Motacilla alba* (Linnaeus, 1758)	WV	I	LC	-	IV	→	√	√	√	√	√	

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82	White-browed Wagtail	*Motacilla maderaspatensis* (Gmelin, 1789)	R	I	LC	-	IV	→	√	√	√	√	×	
Muscicapidae (11)														
83	Black Redstart	*Phoenicurus ochruros* (Gmelin, 1774)	WV	I	LC	-	IV	↑	√	√	√	√	√	
84	Bluethroat	*Luscinia svecica* (Linnaeus, 1758)	WV	I	LC	-	IV	→	√	√	√	√	×	
85	Brown Rockchat	*Oenanthe fusca* (Blyth, 1851)	R	I	LC	-	IV	→	√	√	√	√	√	
86	Indian Robin	*Copsychus fulicatus* (Linnaeus, 1766)	R	C	LC	-	IV	→	√	√	√	√	√	
87	Oriental Magpie Robin	*Copsychus saularis* (Linnaeus, 1758)	R	C	LC	-	IV	→	√	√	√	√	√	
88	Pied Bushchat	*Saxicola caprata* (Linnaeus, 1766)	R	I	LC	-	IV	→	√	√	√	√	√	
89	Red-breasted Flycatcher	*Ficedula parva* (Bechstein, 1792)	WV	I	LC	-	IV	↑	×	×	√	×	×	
90	Siberian Rubythroat	*Calliope calliope* (Pallas, 1776)	WV	I	LC	-	IV	→	√	×	×	×	×	
91	Siberian Stonechat	*Saxicola maurus* (Pallas, 1773)	WV	I	LC	-	IV	→	√	√	√	×	√	1e
92	Taiga Flycatcher	*Ficedula albicilla* (Pallas, 1811)	WV	I	LC	-	IV	→	√	√	×	×	×	
93	Tickell's Blue Flycatcher	*Cyornis tickelliae* (Blyth, 1843)	R	I	LC	-	IV	→	√	√	√	√	×	
Nectariniidae (1)														
94	Purple Sunbird	*Cinnyris asiaticus* (Latham, 1790)	R	N	LC	-	IV	→	√	√	√	√	√	
Oriolidae (2)														
95	Black-hooded Oriole	*Oriolus xanthornus* (Linnaeus, 1758)	R	O	LC	-	IV	→	√	√	√	√	×	
96	Indian Golden Oriole	*Oriolus kundoo* (Sykes, 1832)	R	O	LC	-	IV	?	√	√	√	√	×	
Paridae (1)														
97	Cinereous Tit	*Parus cinereus* (Vieillot, 1758)	R	I	LC	-	IV	↑	√	√	√	√	√	
Passeridae (2)														
98	House Sparrow	*Passer domesticus* (Linnaeus, 1758)	R	O	LC	-	IV	↓	√	√	√	√	√	
99	Yellow-throated Sparrow	*Gymnoris xanthocollis* (Burton, 1838)	R	O	LC	-	IV	→	√	√	√	√	√	
Phylloscopidae (4)														
100	Blyth's Leaf Warbler	*Seicercus reguloides* (Blyth, 1842)	WV	I	LC	-	IV	→	×	√	×	×	√	
101	Common Chiffchaff	*Phylloscopus collybita* (Vieillot, 1817)	WV	I	LC	-	IV	↑	√	√	√	√	√	
102	Greenish Warbler	*Phylloscopus trochiloides* (Sundevall, 1837)	WV	I	LC	-	IV	↑	√	√	√	×	√	
103	Hume's Warbler	*Phylloscopus humei* (Brooks, 1878)	WV	I	LC	-	IV	→	√	×	×	×	×	
Ploceidae (2)														

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104	Baya Weaver	*Ploceus philippinus* (Linnaeus, 1766)	R	O	LC	-	IV	→	√	√	√	√	√	
105	Black-breasted Weaver	*Ploceus benghalensis* (Linnaeus, 1758)	R	O	LC	-	IV	→	√	√	√	√	√	
Pycnonotidae (2)														
106	Red-vented Bulbul	*Pycnonotus cafer* (Linnaeus, 1766)	R	O	LC	-	IV	↑	√	√	√	√	√	
107	Red-whiskered Bulbul	*Pycnonotus jocosus* (Linnaeus, 1758)	R	O	LC	-	IV	↓	√	√	√	√	√	
Sittidae (1)														
108	Indian Nuthatch	*Sitta castanea* (Lesson, 1830)	R	O	LC	-	IV	?	√	√	√	√	√	1f
Stenostiridae (1)														
109	Grey-headed Canary-flycatcher	*Culicicapa ceylonensis* (Swainson, 1820)	WV	I	LC	-	IV	→	√	√	√	√	×	
Sturnidae (6)														
110	Asian Pied Starling	*Gracupica contra* (Linnaeus, 1758)	R	O	LC	-	IV	↑	√	√	√	√	√	
111	Bank Myna	*Acridotheres ginginianus* (Latham, 1790)	R	O	LC	-	IV	↑	√	√	√	√	√	
112	Brahminy Starling	*Sturnia pagodarum* (Gmelin, 1789)	R	O	LC	-	IV	?	√	√	√	√	√	
113	Common Myna	*Acridotheres tristis* (Linnaeus, 1766)	R	O	LC	-	IV	↑	√	√	√	√	√	
114	Common Starling	*Sturnus vulgaris* (Linnaeus, 1758)	WV	O	LC	-	IV	↓	√	√	×	√	×	1g
115	Jungle Myna	*Acridotheres fuscus* (Wagler, 1827)	R	O	LC	-	IV	↓	√	√	√	√	√	
Turdidae (1)														
116	Black-throated Thrush	*Turdus atrogularis* (Jarocki, 1819)	WV	G	LC	-	IV	?	√	√	√	×	√	
Vangidae (1)														
117	Common Woodshrike	*Tephrodornis pondicerianus* (Gmelin, 1789)	R	I	LC	-	IV	→	√	√	√	√	√	
Zosteropidae (1)														
118	Indian White-eye	*Zosterops palpebrosus* (Temminck, 1824)	R	I	LC	-	IV	↓	√	√	√	√	√	
Pelecaniformes Ardeidae (7)														
119	Black-crowned Night Heron	*Nycticorax nycticorax* (Linnaeus, 1758)	R	O	LC	-	IV	↓	√	√	√	√	×	
120	Cattle Egret	*Bubulcus ibis* (Linnaeus, 1758)	R	C	LC	-	IV	↑	√	√	√	√	√	
121	Grey Heron	*Ardea cinerea* (Linnaeus, 1758)	WV	C	LC	-	IV	?	√	√	√	√	√	
122	Indian Pond Heron	*Ardeola grayii* (Sykes, 1832)	R	C	LC	-	IV	?	√	√	√	√	√	
123	Intermediate Egret	*Ardea intermedia* (Wagler, 1827)	R	C	LC	-	IV	↓	√	√	√	√	√	

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124	Little Egret	*Egretta garzetta* (Linnaeus, 1766)	R	C	LC	-	IV	↑	√	√	√	√	√	
125	Purple Heron	*Ardea purpurea* (Linnaeus, 1766)	R	C	LC	-	IV	↓	√	√	√	√	√	
Ciconiidae (3)														
126	Asian Openbill	*Anastomus oscitans* (Boddaert, 1783)	R	C	LC	-	IV	?	√	√	√	√	√	2f
127	Painted Stork	*Mycteria leucocephala* (Pennant, 1769)	WV	C	NT	-	IV	↓	×	√	×	×	×	2d
128	Woolly-neck Stork	*Ciconia episcopus* (Boddaert, 1783)	R	C	NT	-	IV	↓	√	√	√	√	√	1h
Piciformes Picidae (3)														
129	Black-rumped Flameback	*Dinopium benghalense* (Linnaeus, 1758)	R	O	LC	-	IV	→	√	×	×	×	×	
130	Brown-capped Pygmy Woodpecker	*Yungipicus nanus* (Vigors, 1832)	R	I	LC	-	IV	↑	√	√	√	√	×	
131	Yellow-fronted Woodpecker	*Leiopicus mahrattensis* (Latham, 1801)	R	O	LC	-	IV	→	√	√	√	√	×	
Ramphastidae (2)														
132	Brown-headed Barbet	*Psilopogon zeylanicus* (Gmelin, 1788)	R	F	LC	-	IV	→	√	√	√	√	√	
133	Coppersmith Barbet	*Psilopogon haemacephalus* (Muller, 1776)	R	F	LC	-	IV	↑	√	√	√	√	√	
Psittaciformes Psittaculidae (3)														
134	Alexandrine Parakeet	*Psittacula eupatria* (Linnaeus, 1766)	R	F	NT	II	IV	↓	√	×	√	×	×	2a
135	Plum-headed Parakeet	*Psittacula cyanocephala* (Linnaeus, 1766)	R	F	LC	II	IV	↓	√	√	√	√	√	
136	Rose-ringed Parakeet	*Psittacula krameri* (Scopoli, 1769)	R	F	LC	-	IV	↑	√	√	√	√	√	
Strigiformes Strigidae (3)														
137	Brown Fish Owl	*Ketupa zeylonensis* (Gmelin, 1788)	R	C	LC	II	IV	↓	√	×	√	√	×	
138	Mottled Wood Owl	*Strix ocellata* (Lesson, 1839)	R	C	LC	II	IV	→	√	×	×	√	×	
139	Spotted Owlet	*Athene brama* (Temminck, 1821)	R	C	LC	II	IV	→	√	√	√	√	×	

IUCN: International Union for Conservation of Nature and Natural Resources; CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora; IPWA: Indian Wildlife Protection Act; R: Resident, WV: Winter Visitor, SV: Summer Visitor; C: Carnivorous; O: Omnivorous; I: Insectivorous; F: Frugivorous; G: Granivorous; N: Nectarivore; LC: Least Concern; EN: Endangered; VU: Vulnerable; NT: Near Threatened; CITES II: Appendix-II species of CITES are the ones that are not necessarily threatened now with extinction but may become so unless trade is closely controlled; III: Appendix-III species of CITES are those species which are already regulated for trade by the country and that needs the cooperation of other countries to prevent unsustainable and illegal exploitation; IWPA I: Schedule - I species of IWPA (high priority species); IV: Schedule - IV species of IWPA (relatively low priority species); V: Schedule - V species of IWPA (vermin - species which are harmful to crops, livestock and perceived as causing problems for the society); ?: Unknown; →: Stable; ↑: Increasing; ↓: Decreasing; SHW: Sohawal; RDL: Rudauli; MKP: Milkipur; BKP: Bikapur; SDR: Sadar; √: Species recorded in the site; ×: Species not recorded in the site.

district, eastern Uttar Pradesh, India (Table 2). Similar studies in agricultural landscapes have reported 144 species in Burdwan, West Bengal (Hossain & Aditya 2016), 128 species in Nalgonda District, Telangana (Narayana et al. 2019) and 107 species in Assam (Yashmita-Ulman et al. 2021a). In India, Passeriformes is the most dominant order (Praveen et al. 2016) and was found to be the most dominant order with 28 families and 76 species (Figure 2) in this study also. This finding is also consistent with the study of Kumar & Sahu (2020). Most species that have been recorded during our study are residents followed by winter and summer visitors (Figure 3). Hossain & Aditya (2016) in West Bengal, Narayana et al. (2019) in Tamil Nadu and Kumar & Sahu (2020) in Haryana have also found that the majority of the birds recorded from agricultural landscapes were resident in nature, followed by winter visitors and summer visitors. Uttar Pradesh being a part of the Central Asian Flyway serves as a wintering site for the migratory birds travelling from northern part of Asia and parts of Europe. The migratory birds usually prefer areas having congenial environment, enormous food availability and safe and secure sites as wintering grounds (Mukhopadhyay & Mazumdar 2017). Most of the tehsils in Ayodhya district are blessed with seasonal and perennial wetlands that attract a large population of migratory birds (pers. obs.). This is one of the reasons for encountering such high numbers of migrants in the study area.

Six foraging guilds are found in the study area, omnivores being the most dominant (Figure 4). This result contradicts those of other studies (e.g., Narayana et al. 2019; Kumar & Sahu 2020) who have reported insectivores to be the most dominant feeding guild in agricultural landscapes. Out of all the avifauna recorded, 87 bird species (63%) were found in all the study sites, whereas 52 bird species (37%) are recorded only in some study sites (Table 2). The fact that the bird species observed in the study area were mainly omnivores and a majority of them were found in all the study sites, indicates that the bird species occurring in agricultural fields are generalists in nature. They might have adopted themselves to the instability of food (fields are cultivated only for some parts of the year) and therefore feed on both plant and animal matter. Family Muscicapidae is known to be the most diverse family in India (Manakadan & Pittie 2001) and our results also indicate that Muscicapidae along with Accipitridae are the most diverse families (11 species each, RDi= 7.91) (Table 3), conforming to this statement.

In the present study, Sohawal tehsil recorded the

Table 3. Relative diversity (Rdi) of various avian families in agricultural landscapes of Ayodhya district, eastern Uttar Pradesh, India.

Avian family	Number of species recorded	Rdi value
Accipitridae	11	7.91
Muscicapidae	11	7.91
Ardeidae	7	5.04
Columbidae	7	5.04
Cuculidae	7	5.04
Motacillidae	6	4.32
Sturnidae	6	4.32
Hirundinidae	5	3.60
Alaudidae	4	2.88
Cisticolidae	4	2.88
Phylloscopidae	4	2.88
Campephagidae	3	2.16
Ciconiidae	3	2.16
Corvidae	3	2.16
Estrildidae	3	2.16
Laniidae	3	2.16
Leiothrichidae	3	2.16
Picidae	3	2.16
Psittaculidae	3	2.16
Strigidae	3	2.16
Acrocephalidae	2	1.44
Alcedinidae	2	1.44
Apodidae	2	1.44
Charadriidae	2	1.44
Meropidae	2	1.44
Oriolidae	2	1.44
Passeridae	2	1.44
Phasianidae	2	1.44
Ploceidae	2	1.44
Pycnonotidae	2	1.44
Ramphastidae	2	1.44
Aegithinidae	1	0.72
Bucerotidae	1	0.72
Coraciidae	1	0.72
Dicaeidae	1	0.72
Dicruridae	1	0.72
Falconidae	1	0.72
Glareolidae	1	0.72
Gruidae	1	0.72
Monarchidae	1	0.72
Nectariniidae	1	0.72
Paridae	1	0.72
Rallidae	1	0.72
Sittidae	1	0.72
Stenostiridae	1	0.72
Turdidae	1	0.72
Upupidae	1	0.72
Vangidae	1	0.72
Zosteropidae	1	0.72

Table 4. Measurements of avian diversity and richness at agricultural landscapes of Ayodhya District, eastern Uttar Pradesh, India.

Tehsil (Study sites)	Species richness	SWI	SDI	PEI
Sohawal	133	4.3	0.01	0.87
Rudauli	126	4.28	0.01	0.88
Milkipur	119	4.25	0.01	0.88
Bikapur	114	4.23	0.01	0.89
Sadar	98	3.86	0.03	0.84

SWI—Shannon-Weiner Diversity Index | SDI—Simpson's Dominance Index | PEI—Pielou's Evenness Index.

Table 5. Sorenson's Similarity Index of avian species between selected agricultural landscapes of Ayodhya district, eastern Uttar Pradesh, India.

	Sohawal	Rudauli	Milkipur	Bikapur	Sadar
Sohawal	0.00				
Rudauli	0.93	0.00			
Milkipur	0.92	0.94	0.00		
Bikapur	0.91	0.92	0.92	0.00	
Sadar	0.82	0.86	0.84	0.84	0.00

highest species richness and Shannon-Weiner diversity index (133, 4.30) (Table 4). The bird species richness and community structure depends upon the availability of food, roosting and nesting sites (Narayana et al. 2019), anthropogenic pressure (Yashmita-Ulman et al. 2020), geographical area & size, topographical features & climatic conditions of the area. The agricultural fields in Sohawal offer food in the form of rice & wheat grains & mustard seeds from time to time. This tehsil also has a presence of very diverse habitats. It is interspersed by small to large water bodies, agroforestry systems (trees like *Eucalyptus* sp. or *Tectona grandis* planted on farm bunds), plantations of *Eucalyptus* sp. or *Tectona grandis* and orchards of *Mangifera indica* or *Psidium guajava* making the landscape heterogeneous in nature. Due to this, the area offers very diverse food supply catering to the needs of birds belonging to different foraging guilds. Sundar and Kittur (2013) have reported that agricultural fields having wetlands in vicinity support diverse bird species. Yashmita-Ulman et al. (2018) have suggested that the presence of trees on bunds or blocks increases the bird diversity in agricultural fields. All these factors might have contributed to the bird diversity positively for this site to have a high bird diversity.

In the current study, the second highest species richness (126) is reported from Rudauli tehsil. The sites selected in Rudauli have Rudauli Reserve Forest in the vicinity and the agricultural fields have patches of trees either planted on bunds or in the form of orchards and plantations which might have influenced the bird diversity positively. Yashmita-Ulman et al. (2021b) in their study have concluded that agro-ecosystems in the vicinity of forests have higher diversity. But at the same time, these selected sites have very few water bodies which might have had a negative impact on the bird diversity. Bird species richness and diversity increase in accordance to presence of vegetation and water bodies (Shih 2018). All these might be the reasons of having a good bird diversity but not at par with Sohawal tehsil. On the other hand, Sadar tehsil mostly forms the heart of the Ayodhya city, having large areas occupied by buildings, settlements and industries. The study sites in this tehsil are, therefore, adversely affected by urbanization and higher anthropogenic disturbances. The urban development leads to habitat alteration thus reducing the availability of suitable habitats for birds (Mukhopadhyay & Mazumdar 2017). This might be the reason for finding the lowest bird diversity in Sadar (Species richness= 98, Shannon Weiner diversity index= 3.86) as compared to that of other selected sites.

Overall eight species of global conservation importance namely, *Aquila nipalensis, Neophron percnopterus* (Endangered), *Antigone antigone, Clanga hastata* (Vulnerable), *Ciconia episcopus, Gyps himalayensis, Mycteria leucocephala, Psittacula eupatria* (Near Threatened) have been reported in the study area (Table 2). This region also supported, 31 species (22%) whose global population trend is decreasing (Figure 5) and 16 species which came under Appendix II and Appendix III of CITES (Table 2). These findings are consistent with the study of Kumar & Sahu (2020). The agricultural lands with diverse species composition (Yashmita-Ulman 2021c), fruiting and flowering pattern (Yashmita-Ulman 2021a), structural diversity and management activities (Peterjohn 2003) prove as suitable breeding and foraging grounds for bird species. Many bird species such as *Ploceus philippinus* (Yashmita-Ulman et al. 2017) and *Antigone antigone* (Sundar 2009) are conserved in human-dominated landscapes due to the religious and traditional beliefs of the local communities. These beliefs immensely contribute in supporting species of conservation concern and species whose global population trend is decreasing in these agricultural landscapes.

CONCLUSION

The present study is the first documentation of the bird diversity found in agricultural landscapes of Ayodhya district, Uttar Pradesh. It is evident from this study that the agricultural landscapes are a potential habitat for the rare, globally threatened and near-threatened birds as well as various other migratory and resident birds. Thus, this paper lends an insight that agricultural landscapes can be harnessed for their conservation values. But such habitats are under constant threats due to anthropogenic activities. Therefore, such landscapes must be regularly assessed for their bird diversity and populations. Further detailed studies should be conducted to understand the factors influencing the diversity of birds in agricultural landscapes and the role these landscapes play in providing feeding, nesting, roosting and breeding sites for birds.

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Image 1a–h. a—*Halcyon smyrnensis* | b—*Prinia inornata* | c—*Upupa epops* | d—*Dicrurus macrocerus* | e—*Saxicola maurus* | f—*Sitta castanea* | g—*Sturnus vulgaris* | h—*Antigone antigone* & *Ciconia episcopus*. © Authors.

Image 2a–h. a—*Psittacula eupatria* | b—*Alcedo atthis* | c—*Neophron percnopterus* | d – *Mycteria leucocephala* | e—*Treron phoenicopterus* |f—*Anastomus oscitans* | g—*Spilornis cheela* | h—*Accipiter badius.* © Authors.

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