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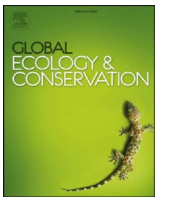

Original Research Article

Assessment of farmers' knowledge and perceptions towards farmland birds show the need of conservation interventions

Hem Bahadur Katuwal[a,b,c], Mingxia Zhang[a,b], Hem Sagar Baral[d,e], Hari Prasad Sharma[f], Rui-Chang Quan[a,b,*]

[a] Southeast Asia Biodiversity Research Institute, Chinese Academy of Sciences, Yezin, Nay Pyi Taw 05282, Myanmar and Center for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla, Yunnan 666303, China
[b] Center of Conservation Biology, Core Botanical Gardens, Chinese Academy of Science, Mengla, Yunnan 666303, China
[c] University of Chinese Academy of Sciences, Beijing 100049, China
[d] Zoological Society of London-Nepal Office, Kathmandu 44600, Nepal
[e] School of Environmental Sciences, Charles Sturt University, Albury-Wodonga, Australia
[f] Central Department of Zoology, Tribhuvan University, Kathmandu 44600, Nepal

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ABSTRACT

Farmland birds are facing a gradual decline in their population globally due to various anthropogenic threats. Understanding farmers' knowledge, attitudes, and perception towards the conservation of farmland birds is crucial to understand distribution and threats, as farmers often come across the birds year-round. We interviewed 743 farmers in four districts (Kapilvastu, Chitwan, Sarlahi, and Sunsari) of lowland Nepal. The majority of the interviewed farmers were male (72%), formally educated (66%), and 16–78 years old. Around 62% of the farmers reported having seen at least one of the 15 birds that we showed them in the interview, of which 57% recognized them correctly. Farmers from protected areas identified more birds than those from non-protected areas. However, the study revealed farmers' poor understanding of birds' names at the species level, nesting, conservation status, ecosystem services provided, and bird hunting as an illegal practice. The majority of the farmers (63%) liked all 15 birds, mainly for their beautiful appearance and sounds. Bird identification ability was correlated with birds' abundance and influenced by the respondent's gender and knowledge on birds' ecological importance. Most farmers perceived that farmland birds decline was mainly due to hunting and trade, pesticides, and lack of nesting trees in the farmlands. The baseline data of this study can be used by policymakers to develop site-specific conservation action plans for farmland birds. We emphasize the pressing need of conservation interventions by government and conservation organizations to increase farmers' knowledge on birds and their ecology and their importance in ecosystems through community outreach programs and school curriculum for farmland bird conservation.

* Corresponding author at: Center for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla, Yunnan 666303, China.
E-mail address: quanrc@xtbg.ac.cn (R.-C. Quan).

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1. Introduction

Anthropocene has immensely catalyzed wildlife population decline and extirpation (Braje and Erlandson, 2013; Wagner, 2019). Many protected areas (PAs) are established globally to protect threatened biodiversity (Coetzee et al., 2014; Xu et al., 2017; Ghosh-Harihar et al., 2019). However, the current PA systems are inadequate for conserving all the globally threatened species as many of them rely on habitats that mainly occur outside PAs (Coad et al., 2019; Kearney et al., 2020). Farmlands outside the PAs occupy around 38% of the land area (World Bank, 2019). Due to landscape and crops heterogeneity, farmlands can also host higher biodiversity (Fahrig et al., 2010; Mulwa et al., 2012; Gonthier et al., 2014), including the highly threatened population of bird species (Sundar and Subramanya, 2010; Wright et al., 2012; DiGaudio et al., 2015; Li et al., 2020). However, agricultural intensification, hunting and trade, land usage degradation, and heavy use of pesticides have severely threatened farmland birds (Herzon and Mikk, 2007; Velho et al., 2012; Ramachandran et al., 2017; Stanton et al., 2018), resulting in rapid and continual population declines globally (Green et al., 2005; Norris, 2008; Reif and Vermouzek, 2019). Some developed countries have implemented conservation programs such as agri-environmental, and stewardship schemes that, although not fully effective (Boatman et al., 2010; Batáry et al., 2015; Palacín and Alonso, 2018), have brought clear benefits to the conservation of farmland birds (Herzon and Mikk, 2007; Baker et al., 2012). Such schemes are absent or rare in most developing countries where farmland birds are highly threatened (Inskipp et al., 2016) and where conservation efforts often prioritize PAs and charismatic megafauna (Basnet et al., 2019; Dhungana et al., 2016; Ghosh-Harihar et al., 2019; Heinen et al., 2019). Bird conservation in farmlands receives relatively little attention from conservation agencies; hence their protection relies heavily on farmer's knowledge, attitudes, and ultimately in their behavior and practices (Wilson and Tisdell, 2005; Ahnström et al., 2013; de Snoo et al., 2013; Kross et al., 2018).

Farmers are the first stakeholders for conserving biodiversity in farmlands. Direct integration of farmers' knowledge, perceptions, and attitudes in the decision-making process is an essential aspect of biodiversity conservation (Ahnström et al., 2013; Mmassy and Røskaft, 2013). The farmers' ecological knowledge can provide necessary information about bird distributions, breeding, threats, and ecosystem services in farmlands (Mmassy and Røskaft, 2013; Silva-Andrade et al., 2016; Gaston et al., 2018; Kross et al., 2018). Farmers' knowledge and attitudes are affected by several socio-economic factors such as gender, age, education, landholding, religion, ethnicity, and proximity to the PAs (Jacobson et al., 2003; Ahnström et al., 2009; Mmassy and Røskaft, 2013; Sah and Heinen, 2001), and also on knowledge on the ecosystem services provided by the birds (Morales-Reyes et al., 2018). However, very few studies have documented the farmers' knowledge and attitudes towards farmland bird conservation (e.g., Jacobson et al., 2003; Mmassy and Røskaft, 2013; Kross et al., 2018), and also knowledge on ecological importance and ecosystem service provided by birds in their farmlands and livelihoods.

In Nepal, farmland supports around 21% (~180 species) of Nepal's birds, of which around 11% are globally threatened (Inskipp and Baral, 2010; Inskipp et al., 2017). However, bird research and conservation in Nepal have primarily focused on PAs, with few farmlands' efforts by the government and conservation organizations (see Baral et al., 2012; Inskipp et al., 2016; MoFE, 2018). Although birds are declining in Nepal (Inskipp et al., 2016), very little is known about their status in the farmlands. This lack of information on the species has created difficulties for preparing conservation plans and government policies. People's knowledge and perceptions help species assess or identify hotspots for conservation (Allendorf et al., 2020). Therefore, we carried out this study to evaluate 1) farmers' knowledge about 15 farmland birds on issues such as sightings, identification, nesting habitat, population trend, and conservation status; 2) knowledge on ecosystem services provided by birds; 3) attitudes towards the birds; 4) perceptions of existing threats to the birds; and 5) knowledge of current laws and regulations against bird hunting in Nepal. We expected farmers living within or close to PAs to recognize more species, have a greater understanding of conservation status, and the current rules and regulations against bird hunting. The outcomes of this research will contribute to the policies on farmland bird conservation introduced by the government, academics, and conservationists.

2. Materials and methods

2.1. Study area

We conducted our study in four districts of lowland, i.e., Kapilvastu in the west, Chitwan and Sarlahi in central Nepal, and Sunsari in the east (Fig. 1). The main human communities residing in these districts are indigenous Tharu, Madhesi, Brahmin, Chettri, Tamang, Rai, etc. (Bennett et al., 2008). The climate in this area is tropical, and the vegetation is dominated by Sal (*Shorea robusta)*, Sissoo (*Dalbergia sissoo)*, Simal *(Bombax ceiba*), and Khair (*Acacia catechu)*.

Our study area includes two PAs, Chitwan National Park in Chitwan and Koshi Tappu Wildlife Reserve in Sunsari district (Fig. 1). As we have also conducted our study within these PAs (buffer zone areas) (Fig. 1), we categorized Chitwan and Sunsari collectively as PAs, Kapilvastu, and Sarlahi non-PAs.

2.2. Data collection

We chose 15 bird species that frequently utilize the farmland habitats of lowland Nepal based on consultation with bird experts, literature review (e.g., Inskipp et al. 2016), and our Farmland Bird Survey Program (Table 1, Supplementary File – Photo Plate 1). Of the 15 selected birds, five were globally threatened as per the International Union for Conservation of Nature (IUCN) Red List of Threatened Species Category (Table 1). Except for Sarus Crane (*Antigone antigone*), which has a reported distribution

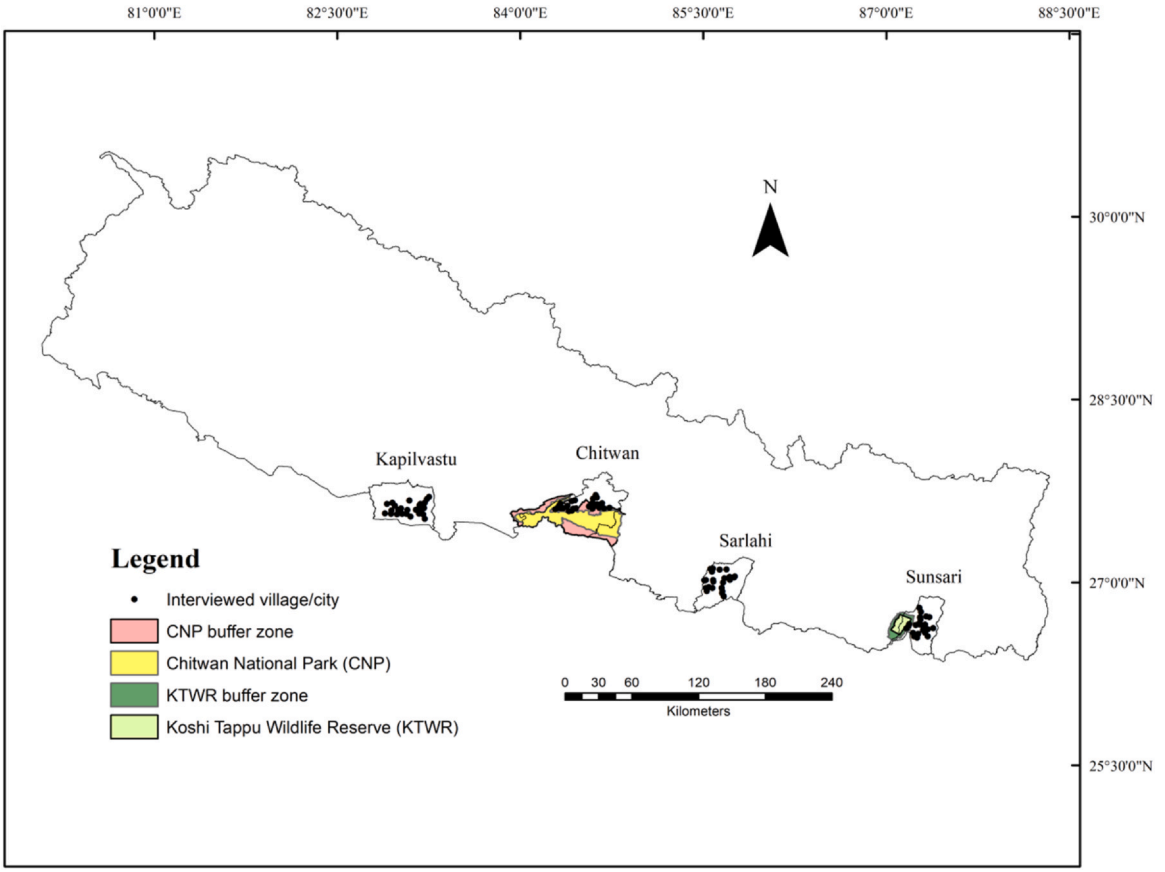

Fig. 1. Study area showing interviews locations in four districts of lowland Nepal.

from central to western Nepal (Katuwal, 2016), all other species have east-west distributions (Table 1; Inskipp et al., 2016). We included the Sarus Crane, a flagship species because it is one of Nepal's nine protected birds. People know the species well for its mythological stories (Inskipp et al., 2016; Baral, 2018). Therefore, we expected that the government had prioritized its conservation and awareness from schools to communities. Similarly, we considered the Yellow-breasted Bunting (*Emberiza aureola*)

Table 1
Details of 15 selected farmland birds for conducting semi-structured interviews of farmers in lowland Nepal.

S.N.	Common name	Scientific name	IUCN status		Migration	Distribution
			Global	National		
1.	Sarus Crane	*Antigone antigone*	VU	VU	Resident	Central-West
2.	Asian Woollyneck	*Ciconia episcopus*	VU	NT	Resident	East-West
3.	Lesser Adjutant	*Leptoptilos javanicus*	VU	VU	Resident	East-West
4.	Indian Spotted Eagle	*Clanga hastata*	VU	VU	Resident	East-West
5.	Yellow-breasted Bunting	*Emberiza aureola*	CR	CR	Winter Visitor/Passage Migrant	East-West
6.	Eurasian Collared Dove	*Streptopelia decaocto*	LC	LC	Resident	East-West
7.	Plum-headed Parakeet	*Psittacula cyanocephala*	LC	LC	Resident	East-West
8.	Asian Openbill	*Anastomus oscitans*	LC	VU	Resident	East-West
9.	Black Drongo	*Dicrurus macrocercus*	LC	LC	Resident	East-West
10.	Black-winged Kite	*Elanus caeruleus*	LC	LC	Resident	East-West
11.	Cattle Egret	*Bubulcus ibis*	LC	LC	Resident	East-West
12.	Long-tailed Shrike	*Lanius schach*	LC	LC	Resident	East-West
13.	Pied Bushchat	*Saxicola caprata*	LC	LC	Resident	East-West
14.	Asian Pied Starling	*Gracupica contra*	LC	LC	Resident	East-West
15.	Paddyfield Pipit	*Anthus rufulus*	LC	LC	Resident	East-West

Note: Asian Woollyneck was down-listed to NT from VU in August 2020 (BirdLife International, 2020)
The IUCN conservation status (CR- Critically Endangered, VU- Vulnerable, NT- Near-threatened and LC- Least Concern), migration, and distribution of each species was based on Inskipp et al. (2016).

because it has faced a global population decline (Kamp et al., 2015). And, also it is a winter visitor (as well as passage migrant) and can be seen in large flocks (50 to more than 1000 individuals) for almost six months a year (November-May) in Nepal. The other 13 species are year-round residents reported breeding in Nepal's lowland mosaics of farmlands (Table 1; Inskipp et al., 2016; Hem Sagar Baral personal observations for three decades). Photographs of all these 15 species were printed (4″x6″) and shown to the farmers during interviews (Supplementary File - Photo Plate 2).

We had initiated a Farmland Bird Survey Program in 2018 in the same four districts (see Katuwal et al., 2020) to determine the abundance of these 15 birds in the farmlands. For that, we created a 2 × 2 km grid over the study area and systematically (alternately from north to south) selected a total of 100 grids (24–26 in each district), all of them containing extensive farmlands (>15 ha). In each cell, we established a 500 m long transect. We surveyed birds along a width of 50 m for small-sized and up to 150 m for large-sized birds on both sides of these transects (Siegel, 2009; Sundar and Kittur, 2012). The survey was conducted from 5:45–10:15 A.M. on summer days and 6:45–11:15 A.M. on winter days. In total, we completed six visits from April 2018 to April 2019, two trips in each of the three seasons (i.e., summer, monsoon, and winter).

We collected data through face-to-face interviews of 7–8 households selected alternatively in the nearest villages/cities of 99 transects of the Farmland Bird Survey Program (Supplementary File– Table S1; for map see Katuwal et al., 2020) using an open-end questionnaire (Singer and Couper, 2017). The participants were selected depending on their willingness to participate in the interview and availability of adult farmers (either male or female; age ≥ 16 years). We took the interviews in local languages from November 2018 to January 2019. The questionnaire was divided into six sections: 1) farmers' socio-demographic characteristics (name, gender, education, ethnicity, religion); 2) farmers' knowledge on the 15 selected birds (whether they have seen each selected species or not). In case they had not observed the species, the particular species was removed from the list and proceeded with the following questions, i.e., whether they can identify the species, knowledge of nesting habitats, population trends since last ten years, and conservation status of the bird); 3) knowledge on ecosystem services provided by the birds; 4) farmers' attitudes towards the 15 birds (most liking and disliking birds) and towards bird conservation; 5) perceptions on threats to overall farmland birds; and, 6) knowledge on current laws and regulations of the country against the hunting of farmland birds (for detail questions see Supplementary File – Appendix 1).

2.3. Data analysis

We calculated the descriptive statistics of farmers' socio-demographic structures and their knowledge, attitudes, and perceptions towards farmland birds. We analysed multiple answers independently for each open-end question. We confirmed whether farmers correctly identified the bird at group levels (names) (parakeet, dove, drongo, etc.) or species level. Then we calculate the number of farmers who had seen and correctly identified at least one of the 15 birds from all districts. We also extracted the mean abundance of each of the 15 species from our Farmland Bird Survey Program. We conducted a Spearman rank correlation between the numbers of farmers seeing and correctly identifying at least one of the 15 farmland birds from the interview and the mean abundance of each species from the field survey.

We performed a generalized linear model with poisson distribution of the error to evaluate the variation in the number of birds identified by farmers (all birds, threatened birds, and common birds) in each district and site protection status (PAs and non-PAs). The Wald Chi-square test was performed to summarize the 'P′ values in the car package (Fox and Weisberg, 2011). Later, we performed a generalized linear mixed model with poisson distribution in the lme4 package (Bates et al., 2015) to analyze the impact of socio-ecological variables on the number of birds correctly identified by the farmers. Six socio-ecological variables, i.e., gender (male/female), ethnicity (Hill Janjati/Terai Janjati/Khas-Arya/Madhesi) classified based on Bennett et al. (2008), land area they own (hectare), education (illiterate/literate or formally educated), age, and whether they considered birds useful (yes/no) were considered as fixed effects and districts as random effects. We considered the birds' usefulness one of the model variables as we expected that if the farmers think birds are useful or helpful in their farmlands, they have more knowledge about it. All the analyses were performed using R program (R Core Team, 2019).

3. Results

3.1. Demographic characteristics of the farmers

We interviewed 743 farmers (Kapilvastu - 197, Chitwan - 201, Sarlahi - 165, Sunsari - 180) aged 16–78 years from the four districts, among them 72% were male, and 66% were formally educated (Table 2). The majority of the farmers were Hindu (87%), followed by Muslim (8%), and Buddhist (5%). Most of the respondents belonged to the Madhesi community (44%), followed by Khas-Arya (24%), Terai Janjati (19%), and Hill Janjati (14%) owing small lands (mean - 0.77 ha, range 0–4.73 ha) (Table 2).

3.2. Farmers' knowledge on farmland birds

3.2.1. Knowledge on 15 selected birds

Around 62% of the farmers reported seeing at least one of the 15 birds (Fig. 2). Of which 70% reported seeing the common species while only 48% reported seeing the threatened species. Of the farmers who confirmed seeing at least one of the birds, only 57% correctly identified their names (Fig. 2). However, most farmers (92%) were aware of the species' group names (parakeet, dove, and egret) rather than the exact species name. The mean (± SD) of correct bird identification by farmer for all

Table 2
Socio-demography of the farmers participated in the interviews.

Parameters	Sarlahi (%)	Kapilvastu (%)	Chitwan (%)	Sunsari (%)
Gender				
Male	16.20	22.07	16.95	16.82
Female	5.38	4.44	10.09	7.4
Education				
Illiterate	9.83	6.42	9.42	8.6
Primary	6.14	11.47	8.06	5.87
Above Primary	6.01	9.01	9.97	9.15
Religion				
Buddhist	2.43	0	2.02	0.27
Hindu	19.59	22.29	24.05	21.48
Muslim	0.27	4.32	0.94	2.29
Ethnicity				
Hill Janjati	4.08	1.36	6.26	2.04
Madhesi	13.07	15.66	1.22	13.35
Khas-Arya	4.22	3.67	11.03	5.44
Terai Janjati	0.81	6.13	8.85	2.72
Land own				
Large (> 0.338 ha)	10.22	17.36	12.24	9.01
Small (< 0.338 ha)	11.97	9.15	14.8	15.2

species was 6.17 ± 2.10 (range: 0–13); common species 4.58 ± 1.6 (range: 0–10); and threatened species 1.59 ± 1.04 (range: 0–4). A higher number of farmers were able to identify the common species than the threatened ones (Fig. 2). Lesser Adjutant (*Leptoptilos javanicus*) was the most commonly seen and identified species among the threatened species. At the same time, Plum-headed Parakeet (*Psittacula cyanocephala*) were the most commonly seen and identified among the common species (Fig. 2). We found a positive correlation between the numbers of farmers seeing birds (r - 0.66) and correctly identifying them (r - 0.41) with the abundance of the respective birds in the field. Of the farmers who reported seeing the birds, only 30% spotted the birds' nests in their farmland's periphery as well (Fig. 2).

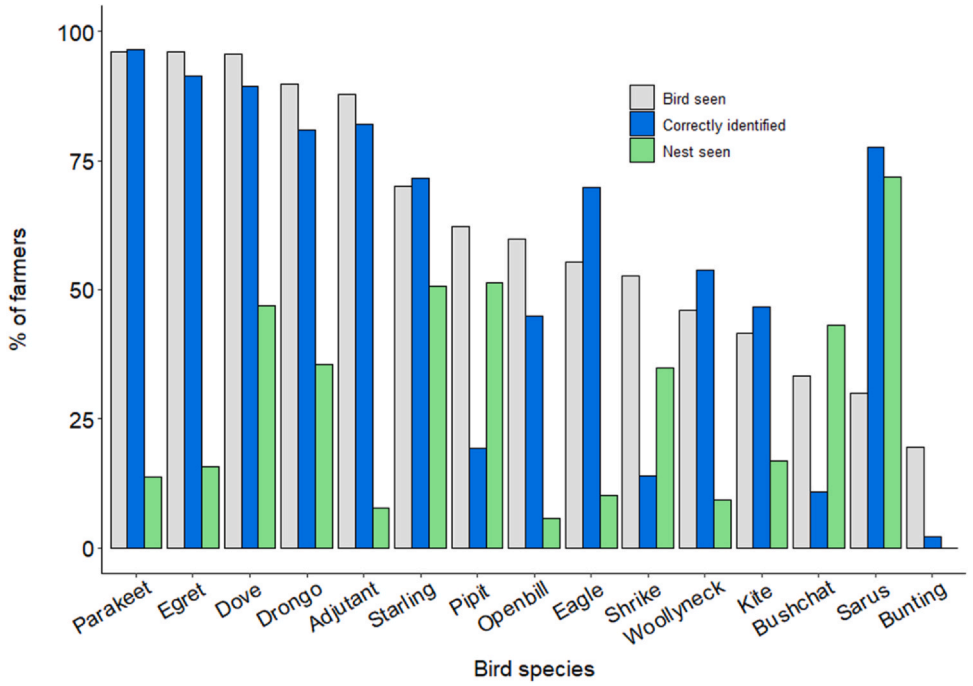

Fig. 2. Farmers' knowledge on 15 farmland birds based on bird seen, correct identification (group names), and nest sighting in their farmlands. The percentage of bird seen was calculated from the total number of the farmer, while the percentage of correct identification and nest observation from the number of farmers who had seen respective birds only. Full names of the species are Parakeet- Plum-headed Parakeet, Egret- Cattle Egret, Dove-Eurasian Collared Dove, Drongo-Black Drongo, Adjutant-Lesser Adjutant, Starling-Asian Pied Starling, Pipit-Paddyfield Pipit, Openbill-Asian Openbill, Eagle-Indian Spotted Eagle, Shrike-Long-tailed Shrike, Woollyneck-Asian Woollyneck, Kite-Black-winged Kite, Bushchat-Pied Bushchat, Sarus-Sarus Crane and Bunting-Yellow-breasted Bunting. For scientific name of birds see Table 1.

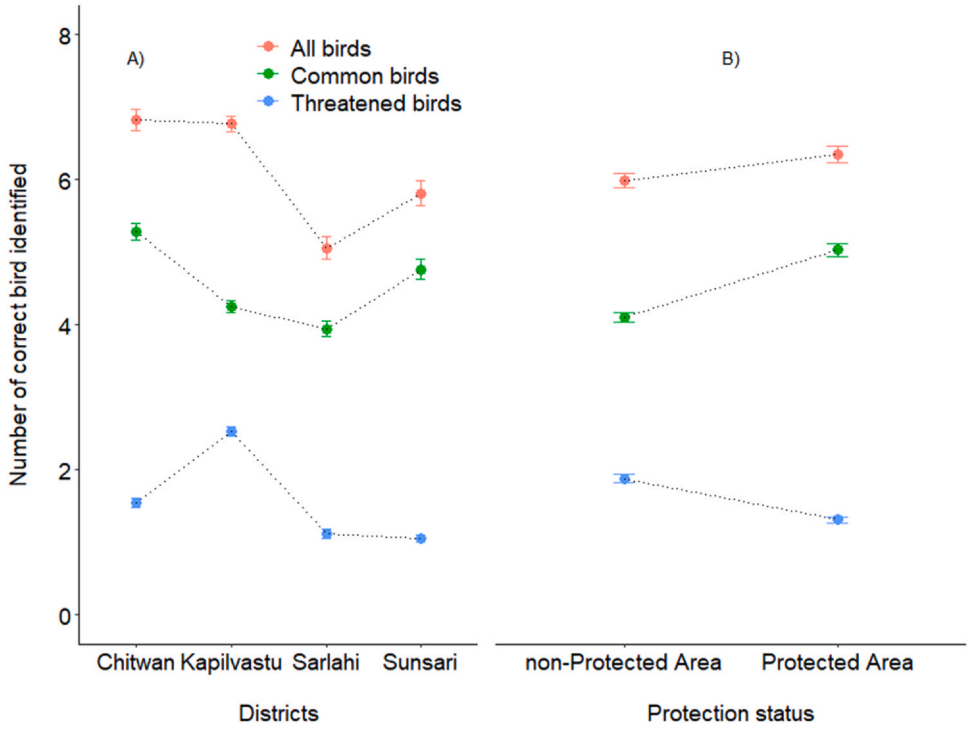

Fig. 3. Number of correct birds identified by the farmers. The mean values are fitted with a standard error at 95% confidence interval.

3.2.2. Correct bird identification ability within study sites

Bird identification capability of the farmers varied among the four districts (all birds: χ^2 - 61.65, df - 3, P < 0.001; threatened birds: χ^2–156.57, df - 3, P < 0.001; common birds: χ^2 - 41.70, df - 3, P < 0.001; Fig. 3A). Farmers from Chitwan identified more birds (all birds and common birds), but farmers from Kapilvastu identified more threatened birds (Fig. 3A). In contrast, the farmers from Sarlahi identified the least number of birds (Fig. 3A). The farmers living within the PAs and non-PAs also showed greater variability in identifying the birds (all birds: χ^2 - 3.72, df - 1, P - 0.053; threatened birds: χ^2 - 37.38, df - 1, P < 0.001; common birds: χ^2 - 34.42, df - 1, P < 0.001; Fig. 3B). Farmers living in the PAs identified more birds (all birds and common birds), while farmers from the non-PAs identified more threatened birds (Fig. 3B).

3.2.3. Population trend of the 15 birds

Around 48% of the farmers reported a continued decline of at least one bird population, whereas 11% reported it to be increasing and 22% said to have a stable population while the remaining had no idea (Fig. 4). Around 71% and 63% of the farmers reported Asian Woollyneck (*Ciconia episcopus*), and Lesser Adjutant as the most declining species, respectively (Fig. 4). However, 39% of the farmers speculated a declining trend for Plum-headed Parakeet, while 21% perceived its increasing population (Fig. 4). Almost all the farmers lacked (98%) knowledge of the birds' conservation status and confirmed that no one had conducted bird awareness programs/activities in their localities.

3.2.4. Ecosystem services and socio-ecological factors affecting bird identification

Although 58% of the farmers said birds are useful in the farmlands, they mentioned a few birds' ecosystem services. Among those who mentioned some service, 94% said birds help control agricultural pests (62% said invertebrate while 32% said vertebrate), 4% said enhancing pollination, while 2% noted aesthetic service (making farmland beautiful).

We found gender and bird usefulness were the most influential socio-ecological variables in bird identification knowledge among the farmers than education, age, land, and ethnicity (Table 3). Male respondents identified more birds than females, while farmers who think birds are useful for the farmlands had more knowledge on bird identification. Farmers also confirmed that local schools had not taken any significant steps, such as bird awareness programs to improve their bird knowledge (Supplementary File - Fig. S1).

3.3. Farmer's attitude toward farmland birds

Almost all the farmers (98%) showed a positive attitude towards the birds demonstrated during the interview. The majority of the farmers (63%) said they liked all 15 birds, mainly for their beautiful appearance (looks good) and sounds. Although 23% of farmers liked especially Plum-headed Parakeet, 37% also showed a negative attitude. Also, few farmers (5%) disliked Eurasian

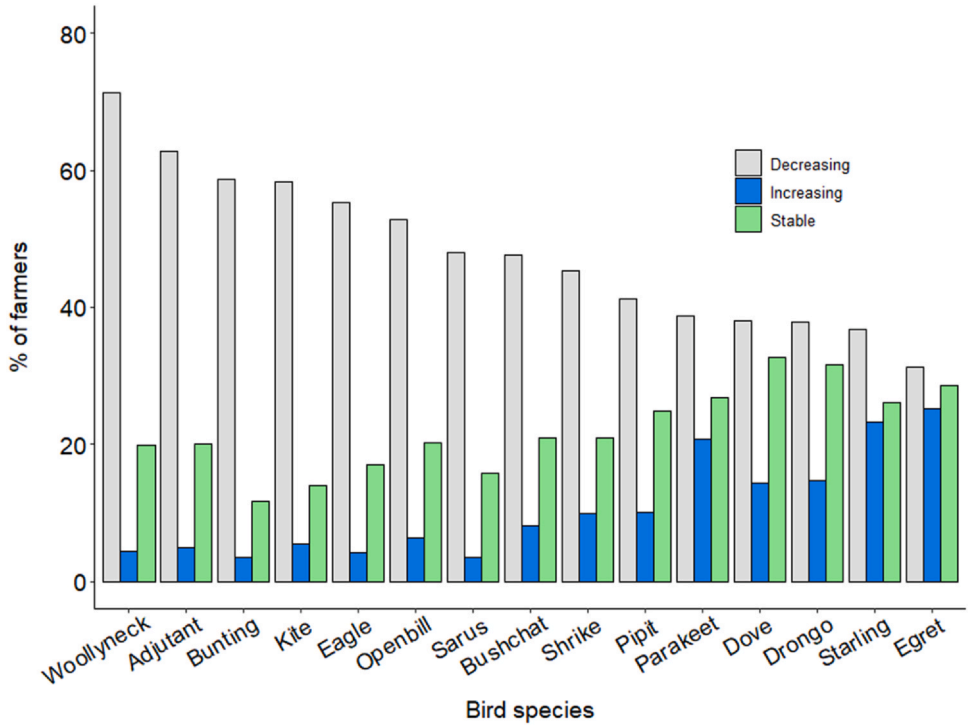

Fig. 4. Farmers' perception on the population trend of 15 interviewed birds. Percentage of bird increasing, decreasing or stable was calculated based on the number of farmers who only saw respective birds. Full names of the species are Parakeet- Plum-headed Parakeet, Egret- Cattle Egret, Dove-Eurasian Collared Dove, Drongo-Black Drongo, Adjutant-Lesser Adjutant, Starling-Asian Pied Starling, Pipit-Paddyfield Pipit, Openbill-Asian Openbill, Eagle-Indian Spotted Eagle, Shrike-Long-tailed Shrike, Woollyneck-Asian Woollyneck, Kite-Black-winged Kite, Bushchat-Pied Bushchat, Sarus-Sarus Crane and Bunting-Yellow-breasted Bunting. For scientific name of birds see Table 1.

Collared Dove (*Streptopelia decaocto)* and Asian Pied Starling (*Gracupica contra*). The majority of the farmers (93%) who showed a hostile attitude revealed the primary cause, especially Plum-headed Parakeets, was their high intensity of crop damage (for example, maize, wheat). Similarly, few farmers (4%) also showed a negative attitude towards the raptors for killing poultry. However, almost all the farmers (97%) showed positive attitudes towards conserving the farmland birds.

3.4. Farmers' perception on threats to farmland birds

Only 19% of the farmers admitted to having hunted the birds themselves (within the age of 10–20) for fun and food purpose. Although 10% of the farmers were unaware of the threats, the remaining (90%) speculated that hunting and pesticide use, followed by a lack of nesting trees, habitat fragmentation and degradation, and lack of food to be the main threats the farmland birds (Fig. 5A).

Only 56% of the farmers expressed their views about farmland bird hunting. Around 60% said people hunt birds for food, 23% said for fun, 15% said for income, and very few said for conflicts. Among the hunting age groups, 48% of the farmers revealed that children hunt the most, 12% said youth, while 40% indicated that all the age groups hunt. The farmers who expressed their views

Table 3
Summary of the socio-ecological variables impacting the farmers' knowledge on bird identification using a generalized linear mixed model. Gender (male/female), bird usefulness (yes/no), land area (ha), ethnicity (Terai Janjati/Khas-Arya/Hill Janjati/Madhesi), education (illiterate/literate or formally educated), and age were fixed factor and districts were a random factor.

Variables	Estimate	Standard Error	Z	P
Intercept	1.660	0.101	16.483	<0.0001
Education: Literate	-0.023	0.041	-0.582	0.560
Ethnicity: Madhesi	-0.021	0.056	-0.386	0.699
Ethnicity: Khas-Arya	-0.029	0.054	-0.544	0.586
Ethnicity: Terai Janjati	0.068	0.057	1.185	0.235
Bird usefulness: Yes	0.113	0.034	3.244	0.001
Land	-0.011	0.022	-0.497	0.619
Age	0.0002	0.001	0.171	0.864
Gender: Male	0.122	0.042	2.859	0.004

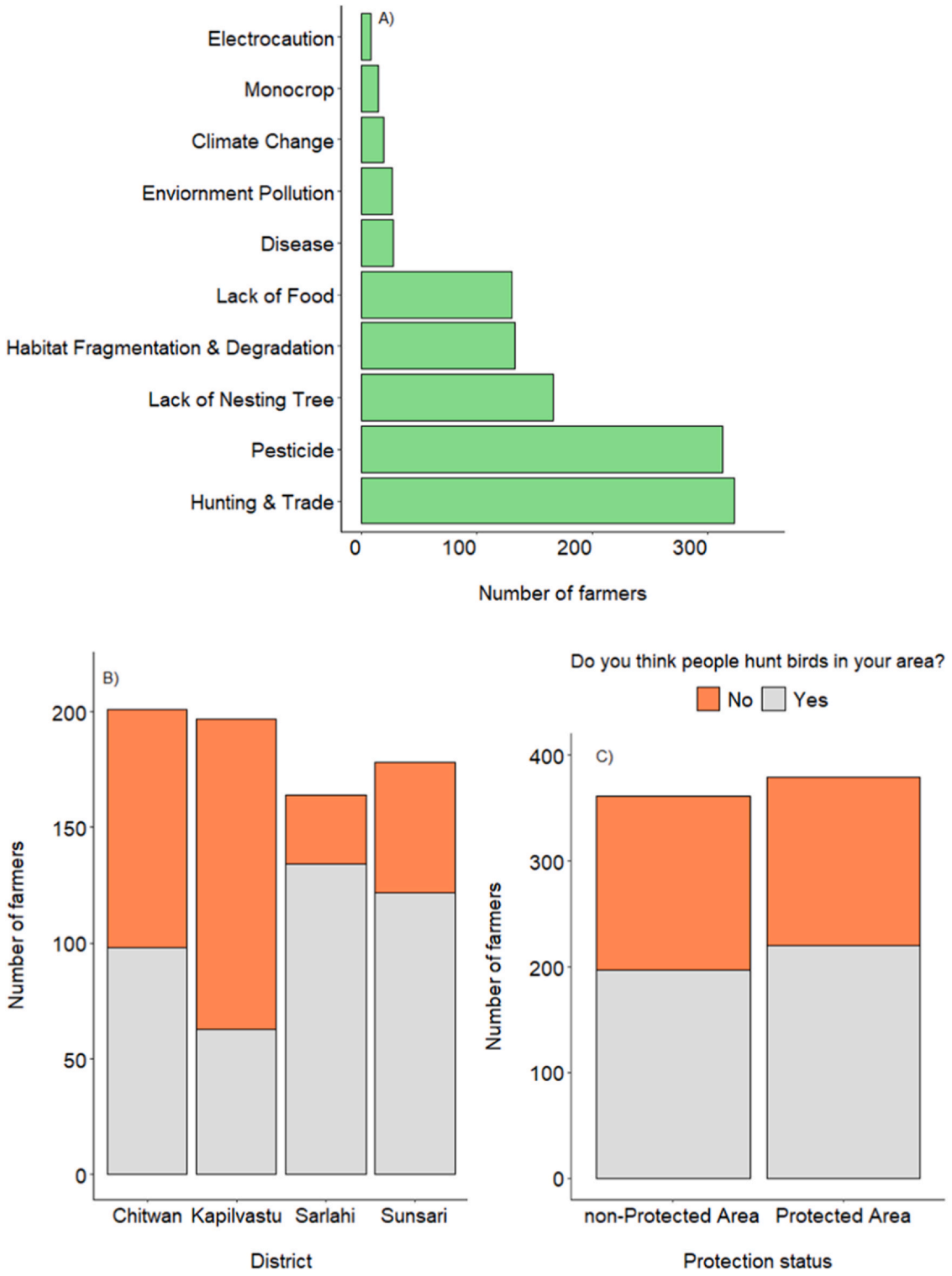

Fig. 5. Farmers' perception on existing threats to farmland birds, A) overall threats, B) and C perception on the presence of hunting in different districts and protection status.

on hunting communities revealed that people mainly from the poor ethnic/indigenous and semi-nomadic communities (mentioned by 75% of respondents) hunt birds, while 25% said all communities hunt. Farmers reported more hunting from the PAs than non-PAs; however, at the district level, high hunting was reported from Sarlahi, followed by Sunsari district (Fig. 5B-C).

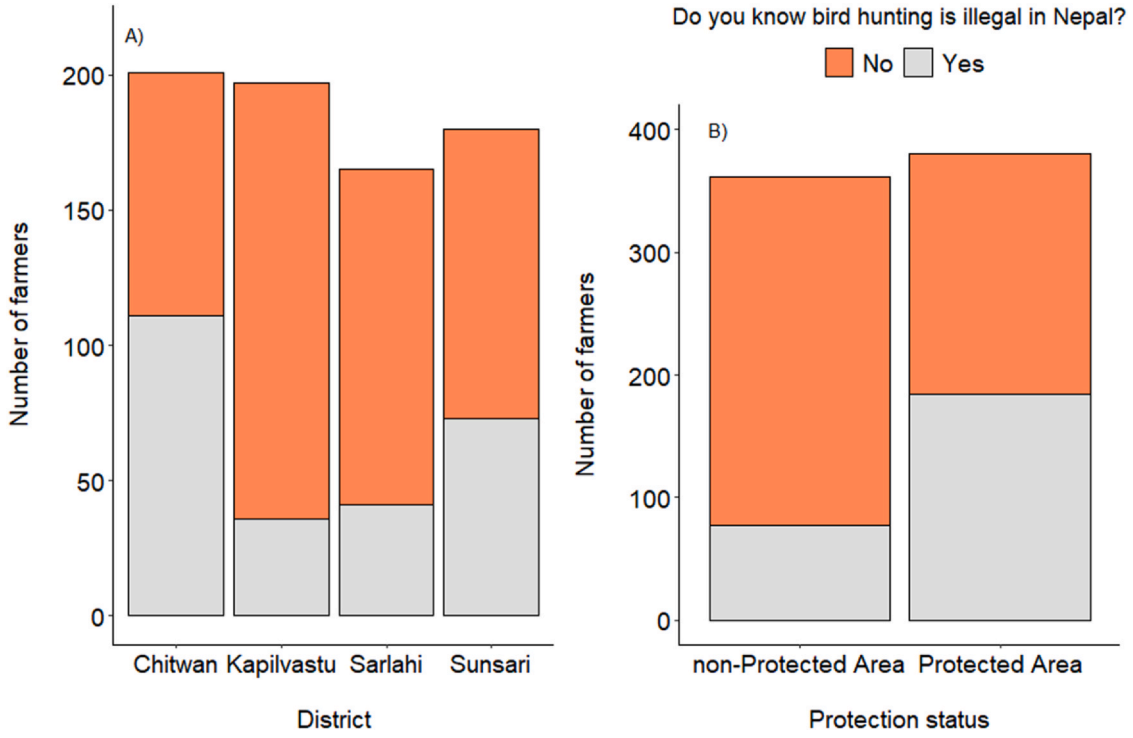

Fig. 6. Farmers' knowledge on bird hunting as illegal practice in Nepal (against law of Nepal).

3.5. Knowledge of existing laws against the hunting of farmland birds

About 65% of the farmers were unaware that bird hunting is illegal (against the law) in Nepal. The knowledge significantly varied among districts (χ^2 - 70.154, df - 3, P < 0.001) and site protection status (χ^2 - 58.305, df - 1, P < 0.001) (Fig. 6). Farmers from Chitwan had the highest knowledge on bird hunting as illegal practice (Fig. 6A) while non-PAs farmers had comparatively lower (Fig. 6B).

4. Discussion

This study confirms that most farmers had seen and identified the common and widely distributed species in their farmlands. Their knowledge is related to the abundance of the birds. Also, farmers had less understanding of birds' names at the species level, threatened species, nest sighting, conservation status, ecosystem services, and illegality of bird hunting.

The farmers from the PAs (e.g., Chitwan) expressed relatively more knowledge. It might be due to the higher abundance of birds seen in this area (Grimmett et al., 2016; Inskipp et al., 2016), as abundant species have higher encounter rates (Noor et al., 2016) and more recognized by people (Kai et al., 2014). Also, the flow of tourists for bird watching might encourage local people on birds' knowledge. The other possible reasons for more knowledge on some common species like parakeet and dove might be their potentiality of keeping pets and trade at the local market (Hem Sagar Baral personal observation). However, factors such as bird's size, physical appearance, population, and hunting activities might increase farmers' knowledge of the threatened species. For example, farmers from Kapilvastu than other areas identified the Sarus Crane, probably due to their larger population size in the area (Katuwal, 2016; Baral, 2018). Yet, most farmers have not seen or identified other threatened species since they are patchily distributed and have smaller populations.

The farmers speculated the decline of bird populations because they had rarely seen the birds' nests and observed fewer birds than before. BirdLife International (2020) recently down-listed the conservation status of Asian Woollyneck to Near-threatened from Vulnerable, but farmers think its population is declining in their area, as reported uncommonly by Katuwal et al. (2020). The current study also revealed that the farmers might have obtained the birds' knowledge from their own experience or their parents and friends, but not much from the schools, media, or awareness campaigns. Despite a few conservation programs conducted on these species either by the PAs, conservation organizations, or individual projects in lowland Nepal (Baral et al., 2012; Basu Bidari and Anis Timsina personal communication), these programs may not have reached the actual farmers residing away from the cities due to their irregularity or due to changing human population dynamics due to mortality or migration.

The farmers' knowledge of the usefulness of birds had a positive influence on their bird identification capacity. The majority of the farmers in our study reported pest control (> 90%) as only birds' ecosystem services. However, birds are beneficial for

seed dispersal, crop pollination, aesthetic services, etc. (Gaston et al., 2018). Male respondents had a better ability to identify birds than females, perhaps because males spend much more time in the fields and interact with the people/communities more frequently, which might help gain knowledge about birds. However, the number of female interviewees in our sample was smaller than the number of males due to their reluctance to interact with new people (Baral and Gautam, 2007). Despite having a formal education, most of the farmers in our sample failed to identify many birds correctly. It should be noted that the curriculum in the schools does not include the taxonomy, ecology, and conservation status, and ecosystem services provided by these birds. Therefore, including the status and local names of these birds in the curriculum is highly recommended to educate more and more people as people with formal education have better knowledge on the species (Zhang et al., 2020) and transfer of such knowledge later helps in the conservation (Sharma et al., 2019). The ethnic communities have a higher understanding of these species (Mmassy and Røskaft, 2013). In our study area, however, there were no relevant differences between local communities, perhaps because they lived together and exchanged knowledge for a long time (Bennett et al., 2008). Besides, settlements are close to the farmlands, and usually, all age groups work in the farmlands though frequency is low for school goers, so their knowledge might not have varied considerably.

Almost all the farmers showed positive attitudes towards the farmland bird conservation. Still, these attitudes also varied based on the birds' behavioral characteristics, appearance (e.g., beauty), communicative skills, and whether they can be kept as pets or not (e.g., parakeets). However, farmers are sometimes depressed due to the massive loss of the crops caused by the same parakeets. So, the farmers' attitude generally depends on the positive and negative impacts caused by the species on their livelihood (Kross et al., 2018; Onyishi et al., 2021).

In contrast to agricultural intensification (Herzon and Mikk, 2007; Stanton et al., 2018), the farmers in our study perceived hunting and pesticides to be the primary cause of decline among farmland bird populations. PAs have higher bird diversity (Inskipp et al., 2016), farmers also speculated more increased hunting within those areas. For example, when there are holidays, children frequently hunt birds using catapult for food and fun. It is the scenario of the current study area and other areas (Peterson et al., 2017). The adults, mainly from the poor and indigenous communities (Paudel et al., 2020) belonging to lowland Nepal and semi-nomadic (e.g., Nat/Banjara/Chidimar) including some immigrants from north India, are also involved in the hunting and local trade of birds. These people visit different places and hunt birds using various techniques like netting in sugarcane fields and roost hooking with long pointed rods (Hem Bahadur Katuwal personal observation). The farmers usually do not oppose and ignore such activities as they are unaware that hunting birds is illegal. Farmers know that killing Wild Boar (*Sus scrofa*), Spotted Deer (*Axis axis*), or other mammals are offences and against the law of the country as the hunters are being caught and prisoned in Nepal (Paudel et al., 2020). But they do not know that killing a bird is a similar offence. So, farmers from Chitwan and Sunsari (PAs) are pretty well aware of bird hunting's illegality compared to farmers of non-PAs areas. It shows the government's weakness and other conservation organizations to effectively implement and create awareness among people about the existing laws and regulations relating to wildlife crime other than mammals. Another reason for the declining population of farmland birds is the rampant use of pesticides (Mitra et al., 2011; Stanton et al., 2018). Since the farmers do not have proper knowledge of pesticides, they apply pesticides available in the local market. Besides, continuous felling of large-sized trees from farmlands (e.g., Simal Sal, Sissoo) is an additional threat to many birds (Fischer et al., 2010; Clements et al., 2013). There are also other threats such as lack of food, crop intensification, habitat fragmentation and degradation, climate change, disturbances, etc., collectively affecting the survival of the farmland birds in Nepal and globally (Inskipp and Baral, 2010; Inskipp et al., 2016; Stanton et al., 2018).

Since we conducted our interviews with different ethnic communities, it is essential to discuss some potential limitations of the study that might influence our conclusion about farmers having less knowledge of bird names. There are different vernacular names of the birds in local languages. To overcome this problem, we had used local assistants who could speak the local language and were aware of birds' local languages' names. Unknown names of the birds were prior verified with the key informants before conducting the interviews. Although this process had reduced some chances of making mistakes in the birds' names in the local language, we cannot rule out some bird names' mismatches. Considering this unavoidable challenge, we believe this will not significantly impact our overall results and interpretation.

5. Conclusions

We conclude that farmers have little knowledge on farmland birds, especially their name, nest, threatened and conservation status, hunting as an illegal practice, and their role in ecosystem services. The findings of the study will help policymakers to develop a site-specific conservation action plan for farmland birds. Based on that, government and conservation organizations should initiate immediate conservation interventions to update farmers' knowledge on farmland birds. It can be done through prioritizing research, providing alternative livelihoods to the poor local hunters, and conservation of birds in farmlands and educating farmers about the birds and their ecology through community outreach programs and school curriculum.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.gecco.2021.e01563.

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