Ecological role and Ecosystem services of birds: A review

Abstract

Birds play many roles, including predators, pollinators, scavengers, seed dispersers, pests, predators, nutrient cycling, ecosystem engineers, and many other services. However, the global decline in bird populations means that the ecosystem services provided by these birds are also declining (Grimmett et al., 2011). The services birds provide are ecologically and economically important, but are not adequately appreciated due to insufficient information. Therefore, this review article aims to elucidate the role of birds in the agro-ecosystem and their benefits to humans in order to promote their conservation. Healthy bird populations and their habitats would help protect various ecological services that would ultimately improve human well-being.

Keywords: Agricultural ornithology, ecosystem services, conservation, insectivores, pest control by birds

1. Introduction

Birds play a very important role in ecosystems. Birds contribute to all four types of ecosystem services, namely provisioning, regulating, cultural, and supporting (Whelan et al, 2008) (Fig.1). Ecosystem services provide direct and indirect benefits to humans through various types of resources and processes. Bird populations are indirectly also directly helpful to human health by serving as bio-indicators, pollinators, seed dispersers, predators, scavengers and ecosystem engineers through their behaviour and the services provided by bird products (Sekercioglu, 2006; Wenny et al., 2011) (Fig.1). They are an important group of vertebrates in different habitats and ecosystems of the world and are important components of the food chain (Whelan et al., 2008). Birds are an essential part of the food web and nutrient cycling and play an important role in human life culturally, socially, scientifically, and as a food source (Siva and Neelanarayanan, 2021). Birds are known as one of the most important species groups for biodiversity conservation. They keep the environment clean by acting as scavengers, protect the plant community by controlling pests and other vermin, pollinate the plants, support better plant survival through seed dispersal, and provide nutrients to the environment (Durairaj et al., 2017). Bird community assessment has become an important tool for biodiversity conservation and for identifying conservation actions in areas of high human

and animal pressure, especially for aquatic resources. Birds are rightly called bio-indicators of nature (Priyanka et al., 2021). The agricultural ecosystem in intensively cultivated field areas in India posseses a large number of fish, dairy, honey bee and poultry farms dispersed among farmlands. Such farms provide additional food sources to birds fish, animal feeds, bees, nectar and fruit trees or fruits. Thus, agricultural birds include granivorous, frugivorous, nectarivorous, insectivorous, carnivorous and omnivorous species (Mathialagan et al., 2022; Keerthika et al., 2022). Few frugivorous, omnivorous and granivorous species are capable of reproducing efficiently in agro-ecosystems leading to the development of large populations and sometimes causing an economic loss in agricultural production by causing damage to different crops and orchards. In contrast, Carnivorous and insectivorous species are less abundant and have been found useful as they keep a persuasive check on insect and rodent pests of agricultural crops. With this above background in this paper, the role of birds in the ecosystem, especially in agricultural areas, is reviewed, and suggestions are made for future research on bird conservation strategies.

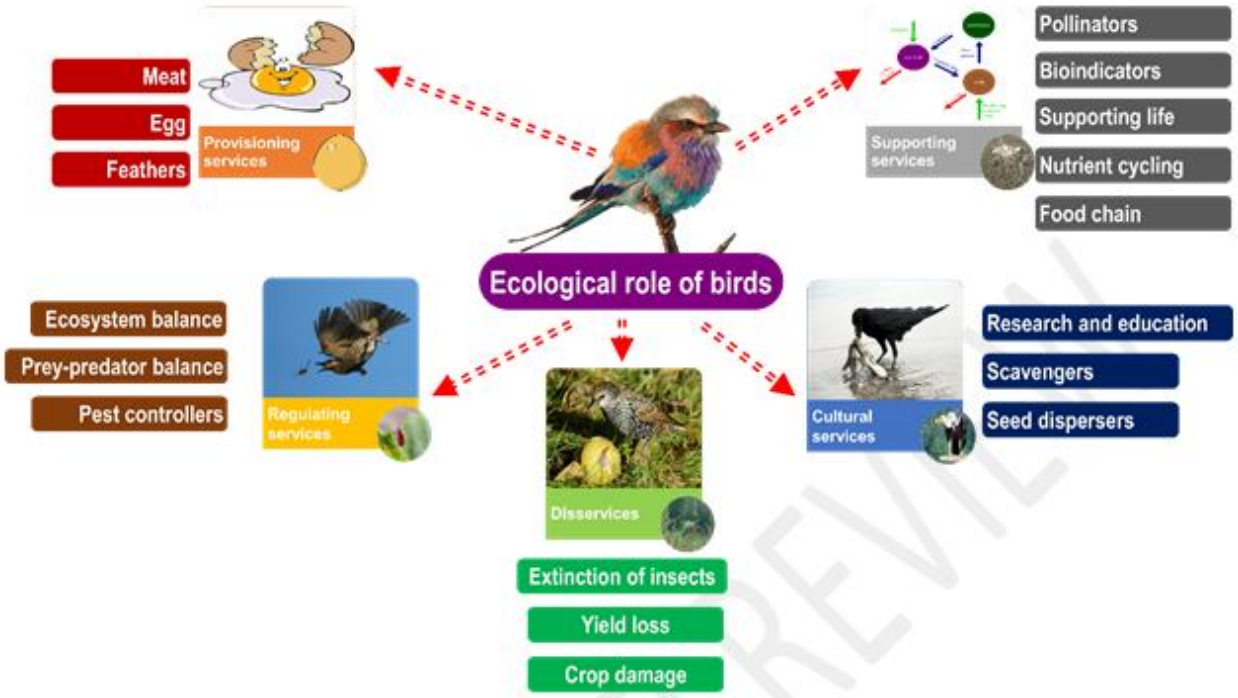

Fig.1. Ecological role and ecosystem services of birds (Modified from Dinesh et al., 2022)

2. Birds as Bio-Indicators

Birds are potential bio-indicators for any ecosystem (Balasubramanyan and Imrankhan, 2016). Birds play an important role in assessing environmental impacts upstream and

downstream. Birds are used to assess ecosystem quality. Long-term monitoring of bird populations indicates changes in natural and man-made ecosystems. It helps to maintain the biodiversity of the region and is also an indicator of minor changes in biodiversity (Jhenkhar et al., 2016). Bird diversity is an important ecological tool that serves as an important indicator for qualitative and quantitative assessment of different habitats. Birds respond to any kind of change in their environmental conditions and therefore are used as bio-indicators (Padoa-Schioppa et al., 2006). Birds are sensitive to changes in the environment and therefore indicate early warnings. Mostly, waterfowl are used as bio-indicators of wetland conditions at both local and regional scales (Zhang and Ma, 2011). The diversity of bird populations serves as a strong indicator of the overall health of an ecosystem (Dendup et al., 2021). Birds are considered good indicators of environmental quality and are often used to monitor environmental and ecosystem health and as bioindicators for inhabited areas (Canterbury et al., 2000). Birds are indicator species for forest habitat quality (Moning and Muller, 2008) and respond to changes in habitat structure and are therefore useful indicators for conservation management at regional and landscape scales (Canterbury et al., 2000). Birds are good sentinel species because they are observable, sensitive to toxicants, and live in a variety of trophic positions (Ferreira, 2011). The unsustainable agropractices in many developing nations caused direct and indirect pollution (Dinesh et al., 2022); in this scenario birds could be used as bioindicators in various cases of environmental pollution, such as raptor population decline caused by DDT (Henny et al., 2010), pollution caused by mining activities (Wayland et al., 2006), and radioactive events such as the Chernobyl disaster (Moller et al., 2011). Many bird species are sensitive to pollution and are indicators of human health risks from pollution (Zhang and Ma, 2011). Bird populations are declining due to climate change, habitat loss, and fragmentation (Ceballosa et al., 2017). Some anthropogenic activities and the release of pesticides and chemicals in the environment are dangerous to bird populations (Garcia and Fernandaz, 2014). In addition to climate change, the use of plastics, radioactive materials, oil, noise, etc., also plays an important role in the sustainability of birds (Richard et al., 2009). If birds depend on a habitat that functions in a certain way, bird population trends can provide information about how well the ecosystem is functioning (Durairaj et al., 2017). The bird population is a sensitive indicator of pollution levels in terrestrial and aquatic ecosystems (Canterbury et al., 2000).

3. Birds as pollinators

Bird-plant interactions in ecosystems and agricultural ecosystems play a major role and have implications for pollination and seed dispersion (Lunberg and Moberg, 2003). Many wild birds play a very important role in food production because of their pollination behaviour (Borges, 2003). For several plant or tree species, pollination is carried out by many Nectarivorus species (Family: Nectariniidae) that feed mainly on nectar. Exclusive pollinators such as bees, birds, and bats play different roles in fruit formation in different wild and domesticated plants (Klein, 2007). The most important pollinators in the ecosystem are bees, flies, and buzzing birds, while pollinators from the lepidopteran group are present but less abundant. Bird pollination is most prevalent in tropical and subtropical regions where flowers and nectar are available throughout the year to support pollination by nectarivorous birds (Merino and Nogueras, 2003). Globally, a total of 920 bird species are involved in pollination (Whelan et al., 2008). Examples of pollinator birds include hummingbirds, sunbirds, false sunbirds, flower peepers, white-eyes, honeyeaters, lories, and honeycreepers (Mahendiran and Azeez, 2018). Sunbirds and spider hunters are the most important insect groups among pollinator birds in Africa and Asia. Honey eaters are important pollinators (Merino and Nogueras, 2003). About 5% of food and medicinal plants are benefited from such pollinator birds.

In India, many studies show that birds such as black drongo, mynas, crows, thrushes, rose-ringed parakeets, golden-backed woodpeckers, bulbuls, flower-peckers, titmice, and lorikeets visit and pollinate flowers (Solomon and Rao, 2006). In total, more than 290 bird species are involved in pollination and seed dispersion, including sunbirds, mynas, starlings, and oriental white-eyes, which are frequent visitors and probably the most important pollinators among the avifauna (Balasubramanian, 2012). Few attempts have been made to evaluate the services of plant and insect pollinators in economic terms, and few attempts have focused on birds (Kellermann, 2008).The role of birds as pollinators has tremendous positive impacts on the ecosystem and agroecosystem by maintaining biodiversity through pollination behaviours that sustain plant species that have direct and indirect benefits to humans and other organisms.

4. Birds as Seed Dispersing Agents

Bird foraging and seed dispersion play an important role in the ecosystem. Seed dispersal is critical to the ecosystem for maintaining biodiversity, species distribution, population dynamics, and ecological balance in the ecosystem. Birds disseminate the seeds of many tree and plant species that are of immediate use to humans, whether for medicine, food, timber, or other

purposes (Asep and Hesti, 2011). These services are mainly observed in frugivorous bird species, which include nearly 48 families (1/3 of all living bird species) that feed exclusively on fruits (Mahendiran and Azeez, 2018). Birds spread seeds over a much greater distance than other dispersal media such as wind (Clark et al., 2005). In natural ecosystems, birds are important dispersers of plant seeds, promoting and maintaining biodiversity and community structure (Charalambidou and Santamaria, 2005). Birds are one of the most important seed dispersers of about 80,000 species of angiosperms, of which about 25,000 are trees, shrubs, and herbaceous plants (Mahendiran and Azeez, 2015). In addition, birds contribute to reforestation in deforested areas by helping in dispersing and germinating seeds, thereby reducing the cost of reforestation (Wunderl, 1997). Birds provide an important ecosystem service by promoting forest growth, which will help mitigate climate change in the future, and they provide a number of other services that primarily benefit humans.

Birds help in the propagation of plant species by acting as seed dispersers (Balasubramanyan and Imran Khan, 2016). Seed dispersal is a process that controls long-term plant community dynamics and vegetation recovery in human-disturbed habitats (Howe and Miriti, 2004). Birds play an important role in maintaining and restoring plant communities as seed dispersers (Pejchar et al., 2008). An important function of frugivorous birds is seed dispersion and pollination (Sekercioglu, 2006). Seed dispersal by birds is thought to significantly affect the patterns of ecological and genetic diversity of many plant species (Karubian et al., 2012). Seeds can adhere to the feathers of birds through structures on the seed. Birds carry seeds, such as those of the mistletoe owl, by carrying them on their beaks after feeding (Herse and Alice, 2021).

The dispersal of seeds by birds is called ornithochory and falls under the group of zoochory, which means seed dispersal by animals (Lambers, 2021). Most ornithochores (plants with seeds disseminated by birds) have conspicuous diaspores that are attractive to fruit-eating birds such as thrushes, pigeons, barbets (Capitonidae), toucans, and hornbills (Bucerotidae). They all either excrete the hard parts containing the embryo or regurgitate those damaged ones. Birds disperse the seeds in a variety of ways, e.g. when feeding, when transferring (they fly with the seed fruit from the second floor and may drop it on their mouthparts), by dropping (the seeds are scattered along with the droppings), by sticking the seeds to their bodies or feet with small hooks or spikes made from the seed structure. Birds play an important role in plant dispersal by

eating a variety of berries and disposing of their waste along with the berry seeds. The birds provide good fertilization with their droppings and provide good growing conditions for the seeds (Tabur and Ayyaz, 2010).

5. Birds as Pest Controlling Agents (Predator)

Predators are one of the most important extrinsic factors acting on animal populations and are a strong selective force in the evolution of form and function (Begon et al., 2005). Birds are dangerous predators with the ability to pounce on unsuspecting animals. They attack insects, reptiles, turtles, and worms (Emmanuel Kingsley, 2022). Eagles, hawks, hawks, owls, kites, and buzzards are some birds of prey. They are grouped under the term birds of prey. The American vulture (Andean condor), *Vultur gryphus*, is the heaviest and largest bird of prey in the world. Integrated pest management uses all available techniques to reduce the occurrence of pests before they cause economic damage and to provide economic benefits to farmers. One of these techniques is biological control, which is a major concern for farmers and an important ecosystem service provided by a variety of organisms and is expected to be a sustainable solution for the agro-ecosystem (Rusch et al., 2016). Birds aid farmers by reducing invertebrate crop pests, yet they are seldom used in Integrated Pest Management (IPM) practices (Dinesh et al., 2018; 2017). The use of avian groups to control insects and other pests in the agroecosystem also causes damage to other valuable plants that have higher economic value. Recent studies have shown that insectivorous birds, which feed mainly on insect populations, play an important role in various agroecologies (Sekercioglu, 2006; Maas et al., 2015).

Insectivorous birds are observed in agricultural ecosystems (Table 1) and reduce pest infestations in many agricultural and horticultural crops such as apples, broccoli, cacao, coffee, corn, kale, grapes, and oil palms. For example, Mols and Visser (2007) reported that birds reduce pest infestations and increase yield by 66 percent in Dutch apple orchards. Similarly, researchers in Borneo reported that pest control by birds prevented 9 to 26 percent of fruit losses in oil palm plantations (Koh, 2008). Birds are among the important and efficient arthropod predators in agroecosystems, with 50 percent feeding primarily on insects and 75 percent occasionally feeding on invertebrates (Whelan et al., 2015). Studies of predation on insect pests by birds in natural and agricultural areas have found that invertebrate reductions by birds range from 20 to 70 percent (Jedlicka et al., 2014). This predation by birds not only reduces the number and

incidence of herbivores but also significantly reduces foliar damage and plant mortality and can result in up to a 60 percent increase in crop yield or fruit production (Whelan et al., 2015).

A study reported that the presence of large numbers of insect herbivores reduced the number of insect pests, resulting in less herbivore damage in coffee plantations in Guatemala (Greenberg et al., 2000). Johnson et al. (2010) reported that the reduction in coffee berry borer damage and the presence of insect herbivores in coffee plantations increased coffee yield and farmer income in Jamaica. In addition, nests of great tits in apple orchards lead to greater numbers of birds in the area feeding on caterpillars that can cause damage to crops, resulting in significantly higher crop yields (Greenberg et al., 2000; Mols and Visser, 2002). The use of birds in pest control can eliminate the need for pesticide use, limiting the use of potentially hazardous chemicals and reducing costs to farmers by eliminating the need to purchase harmful pesticides.

Birds control not only invertebrate pests but also vertebrate pests such as rodents. Field trials conducted in Israel have shown that a trained barn owl scares small rodents and significantly reduces the consumption of seeds by rodents (Ori et al., 2018). Owls have also been shown to control rat populations in various field crops such as wheat, rice, and corn. Oil palm growers in Malaysia use barn owl nests to control rodents in the field because rodents develop resistance to rodenticides such as warfarin and bromadiolone (Duckett, 1991). Previously, a reciprocal relationship between birds and livestock has been noted to be beneficial to humans as well. Because birds are predators, many birds settle on livestock such as cattle and feed on veterinary pests that live on the animals. This behaviour is most commonly observed in cattle egrets, which are particularly known to survive in this manner (Burnie, 2007). The birds benefit from a readily available food source and the animals benefit from the elimination of harmful parasites because of the birds. In many parts of the world, people rely on cows for meat (food) and milk. Milk production declines and cows become very weak when infested with ticks and other parasites. This is confirmed by a study conducted in Pakistan, where birds as prominent predators control these parasites, resulting in healthier and more productive cows (Perveen et al., 2010). In many ways, bird control of parasites on livestock is even more effective than pesticides.

Table.1. List of predatory birds in agro ecosystem

S. No.	Pest	Predator	Reference
1.	Garden snail *(Achatina fulica)* Caterpillars, Insects,	Crow pheasant *(Centropus sinensis)*	Regmi, 2003; Johnson et al.,

	Lizards, Young mice		2010; Asep and Hesti, 2011; Wenny et al., 2011; Luck and Spooner, 2012; Jedlicka et al., 2014; Kale et al., 2014; Mass et al., 2015; Whelan et al., 2015; Rusch et al., 2016; Sekercioglu,2017
2.	Crabs	House crow *(Corvus splendens)*	
3.	Grasshoppers	Cattle egret *(Bubulcus ibis)* Crow pheasant *(Centropus sinensis)* Small green bee eater *(Merops orientalis)* Blue-tailed bee-eater *(Merops philippinus)* Common myna *(Acridotheris tristris)* Bank myna *(Acridotheris ginginianus)* Indian tree pie *(Dendrocitta vegabunda)* House crow *(Corvus splendens)* Red-vented bulbul *(Pycnonotus cafer*)	
4.	Moths and butterflies (Caterpillars)	Magpie robin *(Copsychus saularis)* Black drongo *(Dicrurus adsimilis)* Jungle babble *(Turdoides striatus)*	
5.	Weevils	Indian treepie *(Dendrocitta vagabunda)*	
6.	Aphid	Large-pied wagtail *(Motacilla maderaspatensis)*	
7.	Rats and mice	Owl, Housecrow *(Corvus splendens)* Jungle crow *(Corvus macrorhynchos)*	
8.	Codling moth larvae	Great tit (*Parus major*), blue tit (*Cyanistes caeruleus*), marsh tit (*Poecile palustris*), willow tit (*Poecile montanus*) and Pine siskin (*Spinus pinus*)	
9.	Corn rootworms, cutworms and weevils	Red-winged Blackbird (*Agelaius phoeniceus*)	

6. Birds as Pests

Birds play a dual role in agro-ecosystems, both as pests and as biological control agents: some birds adversely affect agricultural products by feeding on crops while foraging. They cause great damage, especially to ripening cereals, fruits and vegetables and also to young seedlings. Birds cause severe damage to various stages of crops and reduce yield (Table 2) (Suresh and Kambrekar, 2021). Most bird species are insectivores and play an important role in the biological control of pest populations. Thus, they are beneficial to farmers in agriculture and also perform various functions such as nutrient suppliers, which mainly increase soil fertility and predators against rodents. Insectivorous birds have been shown to be successful biological control agents in some agro-ecosystems (Karp et al., 2013). The incidence of non-insect pests on various crops grown in India has been estimated to be about 30 percent of the crop production losses due to insects and non-insect pests. Non-insect pests are enormous and can cause significant damage to our agriculture by severely damaging crops in the field and storing grains in warehouses. The

most common non-insect pests include mites, rodents, birds, wild boars, elephants, etc. (Vishwavidyalaya, 2021).

Table 2.The extent of bird damage in agricultural crops

S. No.	Crop	Stage of damage	Birds	The extent of loss (%)	Reference
1	Groundnut	Ripening	Crows	24	Peer et al., 2003; Tracey & Saunders, 2003; Warburton & Perrin, 2006; Kler,2010; Kale et al., 2014; Tracey et al., 2015; Can-Hernández et al., 2019; Suresh and Kambrekar, 2021
2	Maize	Sprouting	Babblers, Crows, Doves	20	
3	Mustard	Ripening	Crows, Parakeets	63	
4	Pearl millet	Ripening	Parakeets, Sparrows, Weaverbirds	10-100	
5	Peas	Ripening	Pigeon	54	
6	Pulses	Sprouting	Doves, Pigeons, Parakeets, Sparrows	66	
7	Rice	Sprouting Ripening	Cranes, Parakeets, Saras, Sparrows, Weaverbirds, Sparrows, Weaverbirds	41 26	
8	Sorghum	Ripening	Doves, Pigeons	12-85	
9	Sunflower	Sprouting Ripening	Crows Crows, Parakeets,	65 22	
10	Wheat	Sprouting	Crows	17-20	

7. Birds as Scavengers and Sanitary agents

The ability of birds to scavenge on waste is an important means of waste disposal in many places, helping to prevent disease outbreaks that can occur when animal carcasses accumulate (Markandya et al., 2008). Scavenging birds are common in agro-ecosystems and play an important role in foraging, nutrient cycling, and waste removal (Whelan et al., 2008). Vultures play a role in decomposing carcasses. Diurnal raptors such as eagles, hawks, and kites, and corvids such as ravens and crows are also common scavengers (Read and Wilson, 2004). Obligate scavengers are rare in vertebrates but well-known in invertebrates, such as burying beetles, yellow bugs, and blowflies. Fly larvae are also common scavengers of organic material at the bottom of freshwater. For example, the midge fly, *Tokunagayusurika akamusi*, for example, is a scavenger at the bottom of lakes whose adults almost never eat and live only for a few weeks. Scavenging can be a direct and indirect method of disease transmission. Scavengers of infected carcasses can become hosts for certain pathogens and thus be vectors of disease themselves (Read and Wilson, 2004).

Scavengers are very important agents in the ecosystem. Most bird species feed only on animal carcasses, ingesting them opportunistically when available, while the vulture is undoubtedly a known and obligate feeder of this species. Vultures provide one of the most important ecosystem services but are less studied and underappreciated in the avifauna. Through their scavenging, vultures and other carnivorous vertebrates contribute to waste removal, disease regulation, and nutrient cycling (De Vault et al., 2003). Vulture birds keep the environment clean and protect humans, livestock, and wildlife from infections and other contagious diseases by quickly and efficiently disposing of carcasses in the ecosystem. Vultures also have the ability to resist and detoxify bacterial toxins in rotting meat. Vultures' stomachs secrete extremely high levels of acids that result in the killing of all pathogenic bacteria through the consumption of carcasses, thus reducing disease in the ecosystem. In the Serengeti, vultures do excellent job-consuming hundreds of pounds of carcasses per kilometre each year. In Yemen, vultures remove up to 25% of organic waste produced by humans in urban areas (Gangoso et al., 2013).

In India, vulture populations are declining nowadays due to poisoned carcasses and less food competition between wild dogs and rats for carrion, leading to an increase in their population. The increase in these potential disease vectors (wild dogs and rats) led to the outbreak of rabies and dog attacks on humans and also the outbreak of bubonic plague in western India, which killed 54 people in 1994. The decline in vulture populations led to an increase in rabies cases and the death of about 48,000 people (Markandya et al., 2008). This clearly shows that the value of birds to people is very high and underscores the immediate importance of a healthy avifauna to human and ecosystem benefits.

8. Role of birds in nutrient cycling

Bird faeces have significant value in agriculture. In agriculture, bird droppings are used as fertilizer because they contain potassium, nitrogen, phosphate and other nutrients. This can easily convert to ammonia and serve as a good fertilizer for plants by contributing to the nitrogen content of the soil. The contribution of birds to increasing soil fertility on farms is very limited. Recently, it was shown that birds play a 38.0% global contribution in agriculture (Clay, 2004). The transfer of nutrients and the formation of soils are important services provided by birds in an ecosystem that allows primary producers to begin their work, which leads to the distress of primary consumers and leads to the colonization of the area by top predators and the maintenance of biodiversity (MEA, 2005). The role of birds in nutrient cycling has been

demonstrated in many habitats to date. Because of their ability to fly and move through different habitats, birds can transport nutrients from one place to another, which is especially important in areas where plant growth is limited by the availability of nutrients. Birds contribute to nutrient cycling in all habitats, but most impressively in aquatic habitats (Anderson and Polis, 1999).

Ellis (2005) reported that seabirds are more likely to be found in coastal areas, where they process large amounts of food in a small space. In this way, seabirds transport nutrients from the aquatic zone to the terrestrial zone. Large amounts of guano deposits (rich in phosphates, nitrates and potassium) and excreta from birds can influence plant growth and fast-growing vegetation to become more productive compared to lands without birds. Removal of nesting seabirds affects plant growth and plant communities (Croll et al., 2005; Bellingham et al., 2010). This ecosystem service is provided primarily by waterfowl and other coastal birds which transfer nutrients between aquatic and terrestrial ecosystem.

9. Bird Conservation strategies

Despite global awareness of the conservation of birds and their ecological importance, little work has been done to protect the threatened or endangered avifauna in intensively cultivated lands, mainly agricultural areas. While observing the diversity and distribution of various endemic bird species in some areas of India, Gaston (1984) suggested that the bird species may fall to extinction in the areas where habitats are destructed extensively. In India, particularly in an agricultural area, spraying indiscriminate and heavy doses of herbicides and pesticides lead to high mortality of frugivorous and predatory bird species. The abundance of birds of prey has declined significantly due to food chain poisoning and habitat destruction. Woody habitats are often found supporting the highest abundance and species richness of birds in agricultural areas (Jones et al., 2005). There is hardly a lack of information available on residue analysis in birds found in agricultural habitats. Enhancing the benefits cost of birds effectively may be possible by encouraging the birds with some particular beneficial, behavioural or functional trait (Dinesh et al., 2017). It would be an aim of the agriculture ecosystem to enhance birds with particular beneficial or functional traits. The benefits of promoting desirable birds species were confirmed when intercropping sunflower in organic vegetable crops was observed to increase the number and foraging activity of the insectivorous bird species that consumed pest species without inflicting any damage to crops and also get benefit because of sustainable agricultural productivity (Jones and Sieving, 2006). Other

approaches may include targeted control of damage inflicting or pest species by habitat manipulation instead of unsystematic control techniques which may affect the whole birds' community, like scaring devices, reducing agricultural intensification, providing resources to advantageous bird species and promoting diversity. An increase in agricultural birds' species diversity may promote the species responsible for pollination, whereas agricultural uniformity and intensification conversely may enhance damage indirectly by reducing avian species that could keep a check on agricultural pests (Vandermeer et al., 2010. It is hardly possible to quantify the costs and benefits of bird activities in the agro ecosystem, and it is likely to reduce their damage potential and increase the chances of ecosystem services provided by these fascinating creatures.

10. Conclusions

Birds play numerous key roles in agro ecosystems. The seed dispersal behaviour of birds helps to maintain biodiversity and species richness through the distribution of numerous plant species in an ecosystem. In addition, their scavenging behaviours in nature prevent various infectious diseases by cleaning local habitats of carcasses which may harbour pathogenic microorganisms. The primary function of avian predators in biological control programmes is to manage a variety of herbivorous pests, including invertebrate and vertebrate pests, and to boost crop output and also avian predation is indirectly reducing farmers' expenses by avoiding purchasing harmful pesticides. Other services like pollination behaviour also have significant importance in sustaining the ecosystem and human welfare. Most of the services provided by birds have economic and ecological values. In future research, policies focused on the conservation of avifauna, restoration and management of their habitats are highly needed. Conserving and maintaining healthy bird populations and their habitats would preserve diverse ecosystem services by benefiting many living species and human welfare.

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