REPTILES & AMPHIBIANS

# What Are We Saving? The Amphibians and Reptiles of the Rice Paddies in the Balasore District, Odisha, India

Deyatima Ghosh

SM Sehgal Foundation Centre for Biodiversity and Conservation, Ashoka Trust for Research in Ecology and the Environment, Royal Enclave, Srirampura, Jakkur PO, Bangalore, Karnataka- 560064, India

**Abstract.—**Agriculture is widely recognized as one of the major conservation threats to herpetofaunal species. Any conservation actions, particularly those aimed at herpetofauna beyond the network of protected areas, require baseline data on existing species diversity in an area. Unfortunately, most biodiversity studies are focused on producing inventories of animals in a small number of protected areas. To accrue truly meaningful benefits, conservation needs to focus on human-dominated landscapes beyond protected areas, such as agricultural lands. Scientific documentation of farmland herpetofauna is entirely lacking, which could lead to a lack of management and effective inclusion of herpetofauna in conservation. I assessed the species of amphibians and reptiles in tropical rice paddies near the Kuldiha Wildlife Sanctuary in Balasore District, Odisha, India. Based on ecological sampling and community interviews, combined with literature reviews and field guides, I report a total of 55 species including 16 species of amphibians in five families and 39 species of reptiles in 15 families.

On a global scale, herpetofauna are declining more rapidly than birds and mammals (Stuart et al. 2004). The degradation or destruction of habitat (e.g., agricultural development) has been clearly identified as a primary driver for this loss of biodiversity, especially for amphibians and reptiles (Stoate et al. 2009; Cordier et al. 2021). Intensification of agriculture not only impacts farmland herpetofaunal diversity, but also has been reported to cause a decline in the ecosystem services amphibians and reptiles provide in farmlands (Valencia-Aguilar et al. 2013). Nevertheless, amphibians and reptiles have never been at the forefront of conservation needs, especially outside protected areas. The reasons behind this negligence can be attributed to three major factors. First, conservation actions are increasingly being focused toward large charismatic mammals and birds, often overlooking amphibians and reptiles (Vasudevan et al. 2006); second, conservation actions are almost wholly devised for protected areas at the cost of other ecosystems lying outside these areas; and finally, a general lack of understanding about the roles of amphibians and reptiles in the ecosystem and what ecosystem services they provide.

Including neglected species of amphibians and reptiles in management plans is necessary for conserving overall biodiversity at local and regional levels (Chettri et al. 2011). Agricultural lands are unique landscapes that can provide a matrix of land and water ideal for some species of amphibians and reptiles. However, making a considerable shift in agricultural systems from being chemically dependent is crucial to increasing the use of natural resources, considering the vastly detrimental impacts of agricultural chemicals on the environment and human health (WRI 2010). Amphibians and reptiles are important components of farmland biodiversity and provide key irreplaceable ecosystem services such as pollination and crop-pest regulation (de-Oliveira-Nogueira et al. 2023; Romero-Egea et al. 2023). Therefore, in order to harness ecosystem services provided by a rich biodiversity for sustainable agriculture, emphasizing the need for conserving farmland herpetofauna is important.

However, agriculture has been acknowledged as one of the major threats to amphibians and reptiles due to its role in habitat loss, agrochemical input, and conflict (Ghosh and Basu 2020, 2022). Despite studies reporting the loss of herpetofauna from farmlands (Ghosh and Basu 2020; Monagan et al. 2017) and emphasizing the need for their conservation, few efforts to formally document agricultural herpetofauna exist. This is especially true in India (Deuti et al. 2022), which is heavily dependent on agriculture, and therefore the threat level is understandably greater.

Our understanding of the true impact of agricultural intensification on herpetofauna will remain incomplete and insufficient without proper baseline data. Arising from such a need, I herein provide the first formal and systematic





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documentation of amphibian and reptilian species from the agricultural lands of the Balasore District, Odisha, one of the "rice bowls" of India. This landscape has immense conservation value both from the perspectives of species diversity and of the ecosystem services provided by these species. I highlight the need for additional studies to document all types of biodiversity in farmlands to better understand the ecological value and the conservation needs of such important landscapes and species.

**Figure 4.** Actively searching for amphibians and reptiles (left) and surveying local residents (right) to document the herpetofauna in agricultural land in Balasore District, Odisha, India.

## Methods

The Balasore District, in northeastern Odisha (21.49497, 86.94265; Fig. 1), is bounded by West Bengal to the north, the Bay of Bengal to the east, the Bhadrak District to the south, and the Mayurbhanj and Keonjhar Districts to the west. Balasore contains a unique landscape that is a matrix of protected areas and intensive farming. The ratio of forest to agricultural lands in Balasore is 1:16.5 with 220,830 hectares of land under paddy cultivation (Government of Odisha 2024). Agriculture in this region varies in intensity from traditional rain-fed farms to high-intensity farming that is heavily dependent on agrochemicals (Ghosh and Basu 2020; Fig. 2).

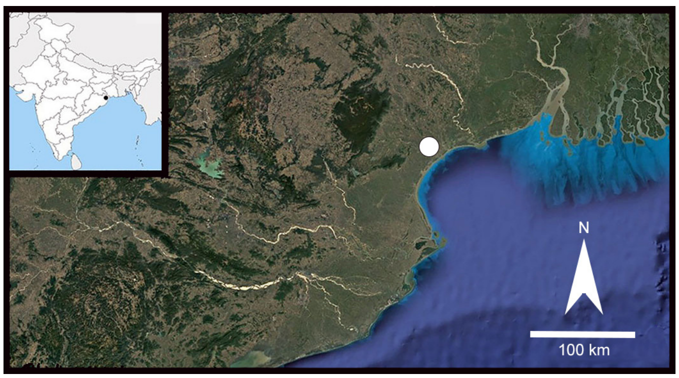


**Figure 1.** Google Earth© image showing the location of the study site in Balasore District, Odisha, India.

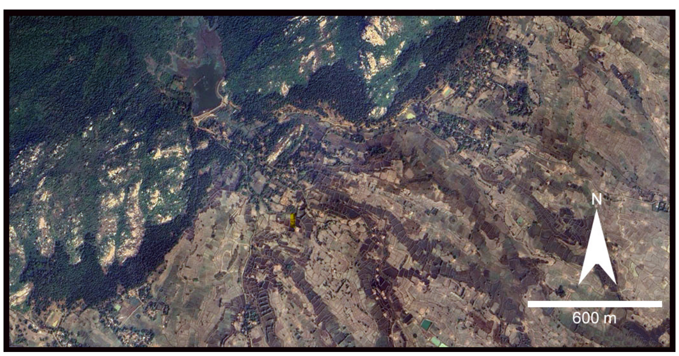


**Figure 2.** Google Earth© image of the landscape in the study region with forest on the left and agricultural lands on the right side of the image.

I conducted ecological surveys from March 2015 through May 2017 in thirteen rice paddies in Balasore. At each farm I surveyed 5 ha of land, and the minimum distance between each site was at least 5 km to ensure independent sampling. Ecological surveys were conducted using drift fences, pitfall traps, double-ended funnels, and cover boards (Fig. 3). Each trap was active for 72 hours and checked daily. Trapping was supplemented by transect walks for visual encounters and active searching by beating bushes (Fig. 4), checking under rocks, in burrows, on tree bark, and in bodies of water.

Community surveys (Fig. 4) complemented ecological sampling; these comprised 300 interviews in 20 villages situated around the survey sites (Table 1), including those where ecological surveys were conducted. Interview questions were focused on species of amphibians and reptiles encountered around villages, changes in the frequency of sightings of animals over the past years, and reasons for their decline. Common local Odia (state language of Odisha) names for all species were used during community interviews, which were conducted with the help of an interpreter.

**Figure 3.** Drift fences used in the surveys of rice paddies in Balasore District, Odisha, India (left); checking the drift-fence traps (right).

**Table 1.** Survey sites where ecological sampling (ES) and community interviews (IN) were conducted in Balasore District, Odisha, India.

| Sampling Sites | Location | Survey Type |
|---|---|---|
| 1 | 21.40510, 86.72153 | ES |
| 2 | 21.35458, 86.68111 | ES |
| 3 | 21.39381, 86.66988 | ES |
| 4 | 21.47703, 86.68701 | ES |
| 5 | 21.47145, 86.63361 | ES |
| 6 | 21.51471, 86.65393 | ES |
| 7 | 21.55961, 86.71500 | ES |
| 8 | 21.54025, 86.73661 | ES |
| 9 | 21.57726, 86.76673 | ES |
| 10 | 21.56120, 86.83156 | ES |
| 11 | 21.59518, 86.81821 | ES |
| 12 | 21.63603, 86.76191 | ES |
| 13 | 21.47581, 86.85260 | ES |
| 14 | 21.40651, 86.40683 | IN |
| 15 | 21.39885, 86.70953 | IN |
| 16 | 21.45488, 86.59928 | IN |
| 17 | 21.45165, 86.60870 | IN |
| 18 | 21.48725, 86.61311 | IN |
| 19 | 21.47006, 86.62296 | IN |
| 20 | 21.46968, 86.59196 | IN |
| 21 | 21.45566, 86.58760 | IN |
| 22 | 21.46290, 86.60700 | IN |
| 23 | 21.60366, 86.82233 | IN |
| 24 | 21.51448, 86.98528 | IN |
| 25 | 21.61715, 86.82566 | IN |
| 26 | 21.61333, 86.83118 | IN |
| 27 | 21.53238, 86.95340 | IN |
| 28 | 21.76985, 87.19138 | IN |
| 29 | 21.75216, 87.16831 | IN |
| 30 | 21.75027, 87.16694 | IN |
| 31 | 21.72215, 87.20606 | IN |
| 32 | 21.75378, 87.21676 | IN |
| 33 | 21.79078, 87.16403 | IN |


**Figure 5.** Amphibians recorded during surveys of agricultural land in Balasore District, Odisha, India: (A) Rough Dwarf Toad (*Duttaphrynus scaber*); (B) Indian Burrowing Frog (*Sphaerotheca breviceps*); (C) Southern Burrowing Frog (*Sphaerotheca rolandae*); (D) Greater Balloon Frog (*Uperodon globulosus*).

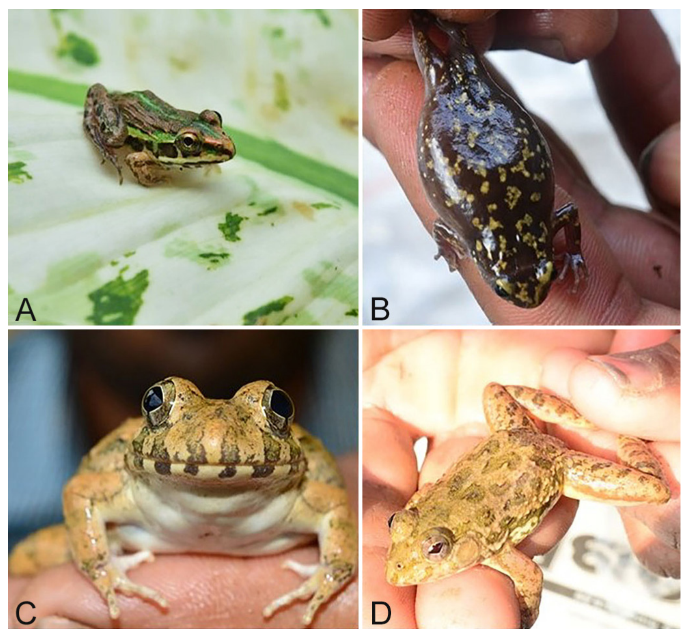


**Figure 6.** Amphibians recorded during surveys of agricultural land in Balasore District, Odisha, India: (A) Indian Bullfrog (juvenile) (*Hoplobatrachus tigerinus*); (B) Marbled Narrow-mouthed Frog (*Uperodon variegatus*); (C) Cricket frog (*Fejervarya* sp.); (D) Indian Skipping Frog (*Euphlyctis cyanophlyctis*).

## Results

I surveyed a total of 13 rice paddies for 2,223 trap hours. Altogether, I identified 55 species, including 16 species of amphibians in five families and 39 species of reptiles in 15 families, in the farmlands by combining ecological surveys and community interviews (Table 2, Figs. 5–11).

Species of conservation concern encountered during the surveys included the Common Sandboa (*Eryx conicus*), Red Sandboa (*Eryx johnii*), and Indian Python (*Python molurus*), all of which are listed as Near Threatened (NT) on the IUCN Red List (IUCN 2024); the Common Kukri Snake (*Oligodon arnensis*) and King Cobra (*Ophiophagus hannah*) are listed as Vulnerable (VU). The Bengal Monitor (*Varanus bengalensis*), Northern River Turtle (*Batagur baska*), and Star

**Table 2.** Amphibians and reptiles in rice paddies in Balasore District, Odisha, India, based on ecological sampling (ES) and community interviews (IN) with threat levels (IUCN Red List) and conservation status in India (Wildlife Protection Act, India, 1972). IUCN Red List categories: LC (least concern), NT (near-threatened), VU (vulnerable), CR (critically endangered).

| Species | Red List | Act 1972 | Source |
|---|---|---|---|
| **Amphibia: Anura** | | | |
| Common Indian Toad, *Duttaphrynus melanostictus* (Schneider 1799) (Bufonidae) | LC | Sch IV | ES, IN |
| Rough Dwarf Toad, *Duttaphrynus scaber* (Schneider 1799) (Bufonidae) | LC | Sch IV | ES |
| Common Indian Treefrog, *Polypedates maculatus* (Gray 1830) (Rhacophoridae) | LC | Sch IV | ES, IN |
| Indian Bullfrog, *Hoplobatrachus tigerinus* (Daudin 1803) (Dicroglossidae) | LC | Sch IV | ES, IN |
| Indian Bullfrog (morph), *Hoplobatrachus tigerinus* (Daudin 1803) (Dicroglossidae) | LC | Sch IV | ES, IN |
| Indian Skipping Frog, *Euphlyctis cyanophlyctis* (Schneider 1799) (Dicroglossidae) | LC | Sch IV | ES, IN |
| Orissa Frog, *Fejervarya orissaensis* (Dutta 1997) (Dicroglossidae) | LC | Sch IV | ES, IN |
| Cricket Frog, *Fejervarya* sp. (Dicroglossidae) | LC | Sch IV | ES |
| Cricket Frog, *Fejervarya* sp. (Dicroglossidae) | LC | Sch IV | ES, IN |
| Indian Burrowing Frog, *Sphaerotheca breviceps* (Schneider 1799) (Dicroglossidae) | LC | Sch IV | ES |
| Southern Burrowing Frog, *Sphaerotheca rolandae* (Dubois 1983) (Dicroglossidae) | LC | Sch IV | ES |
| Yellow-striped Copperback Frog, *Hylarana tytleri* (Theobald 1868) (Ranidae) | LC | Sch IV | ES, IN |
| Marbled Narrow-mouthed Frog, *Uperodon variegatus* (Stoliczka 1872) (Microhylidae) | LC | Sch IV | ES |
| Indian Painted Frog, *Uperodon taprobanicus* (Parker 1934) (Microhylidae) | LC | Sch IV | ES, IN |
| Greater Balloon Frog, *Uperodon globulosus* (Günther 1864) (Microhylidae) | LC | Sch IV | ES, IN |
| Ornate Narrow-mouthed Frog, *Microhyla ornata* (Duméril and Bibron 1841) (Microhylidae) | LC | Sch IV | ES |
| **Reptilia: Testudines** | | | |
| Northern River Turtle, *Batagur baska* (Gray 1830) (Geoemydidae) | CR | Sch I (Part II) | IN |
| Star Tortoise, *Geochelone elegans* (Schoepff 1795) (Testudinidae) | VU | Sch IV | IN |
| **Reptilia: Squamata (lizards)** | | | |
| Bronze Skink, *Eutropis macularia* (Blyth 1853) (Scincidae) | LC | Sch IV | ES, IN |
| White-spotted Supple Skink, *Riopa albopunctata* (Gray 1846) (Lygosomidae) | LC | Sch IV | IN |
| Common Snake Skink, *Riopa punctata* (Linnaeus 1758) (Lygosomidae) | LC | Sch IV | IN |
| Oriental Garden Lizard, *Calotes versicolor* (Daudin 1802) (Agamidae) | LC | Sch IV | ES, IN |
| Peninsular Dwarf Rock Agama, *Psammophilus blanfordanus* (Stoliczka 1871) (Agamidae) | LC | Sch IV | ES, IN |
| Yellow-green House Gecko, *Hemidactylus flaviviridis* (Rüppell 1835) (Gekkonidae) | LC | Sch IV | ES, IN |
| Indian Chameleon, *Chamaeleo zeylanicus* (Laurenti 1768) (Chamaeleonidae) | LC | Sch II (Part II) | IN |
| Asian Water Monitor, *Varanus salvator* (Laurenti 1768) (Varanidae) | LC | Sch I (Part II) | ES, IN |
| Bengal Monitor, *Varanus bengalensis* (Daudin 1802) (Varanidae) | NT | Sch I (Part II) | IN |
| **Reptilia: Squamata (snakes)** | | | |
| Brahminy Blindsnake, *Indotyphlops braminus* (Daudin 1803) (Typhlopidae) | LC | Sch IV | IN |
| Common Sandboa, *Eryx conicus* (Schneider 1801) (Erycidae) | NT | Sch IV | IN |
| Red Sandboa, *Eryx johnii* (Russell 1801) (Erycidae) | NT | Sch IV | IN |
| Indian Python, *Python molurus* (Linnaeus 1758) (Pythonidae) | NT | Sch I (Part II) | IN |
| Copper-headed Trinket Snake, *Coelognathus radiatus* (Boie 1827) (Colubridae) | LC | Sch IV | IN |
| Common Trinket Snake, *oelognathus helenus* (Daudin 1803) (Colubridae) | LC | Sch IV | IN |
| Indian Ratsnake, *Ptyas mucosa* (Linnaeus 1758) (Colubridae) | LC | Sch II (Part II) | ES, IN |
| Banded Racer, *Platyceps plinii* (Merrem 1820) (Colubridae) | LC | Sch IV | IN |
| Streaked Kukri Snake, *Oligodon taeniolatus* (Jerdon 1853) (Colubridae) | LC | Sch IV | IN |
| Common Kukri Snake, *Oligodon arnensis* (Shaw 1802) (Colubridae) | VU | Sch IV | IN |
| Common Wolfsnake, *Lycodon capucinus* (Boie 1827) (Colubridae) | LC | Sch IV | ES, IN |
| Common Catsnake, *Boiga trigonata* (Schneider 1802) (Colubridae) | LC | Sch IV | IN |
| Forsten's Catsnake, *Boiga forsteni* (Duméril, Bibron, and Duméril 1854) (Colubridae) | LC | Sch IV | IN |
| Long-nosed Whipsnake, *Ahaetulla nasuta* (Lacépède 1789) (Colubridae) | LC | Sch IV | ES, IN |
| Brown-speckled Whipsnake, *Ahaetulla pulverulenta* (Boie 1827) (Colubridae) | LC | Sch IV | ES, IN |
| Common Bronze-backed Treesnake, *Dendrelaphis tristis* (Daudin 1803) (Colubridae) | LC | Sch IV | ES, IN |
| Ornate Flying Snake, *Chrysopelea ornata* (Shaw 1802) (Colubridae) | LC | Sch IV | IN |
| Checkered Keelback, *Fowlea piscator* (Schneider 1799) (Natricidae) | LC | Sch II (Part II) | ES, IN |
| Buff-striped Keelback, *Amphiesma stolatum* (Linnaeus 1758) (Natricidae) | LC | Sch IV | ES, IN |
| Green Keelback, *Rhabdophis plumbicolor* (Cantor 1839) (Natricidae) | LC | Sch IV | ES, IN |
| Monocled Cobra, *Naja kaouthia* (Lesson 1831) (Elapidae) | LC | Sch II (Part II) | ES, IN |
| Spectacled Cobra, *Naja naja* (Linnaeus 1758) (Elapidae) | LC | Sch II (Part II) | ES, IN |
| King Cobra, *Ophiophagus hannah* (Cantor 1836) (Elapidae) | VU | Sch II (Part II) | IN |
| Common Krait, *Bungarus caeruleus* (Schneider 1801) (Elapidae) | LC | Sch IV | ES, IN |
| Banded Krait, *Bungarus fasciatus* (Schneider 1801) (Elapidae) | LC | Sch IV | IN |
| Bamboo Pitviper, *Craspedocephalus gramineus* (Shaw1802) (Viperidae) | LC | Sch IV | IN |
| Russell's Viper, *Daboia russelii* (Shaw and Nodder 1797) (Viperidae) | LC | Sch II (Part II) | ES, IN |
| Saw-scaled Viper, *Echis carinatus* (Schneider 1820) (Viperidae) | LC | Sch IV | IN |

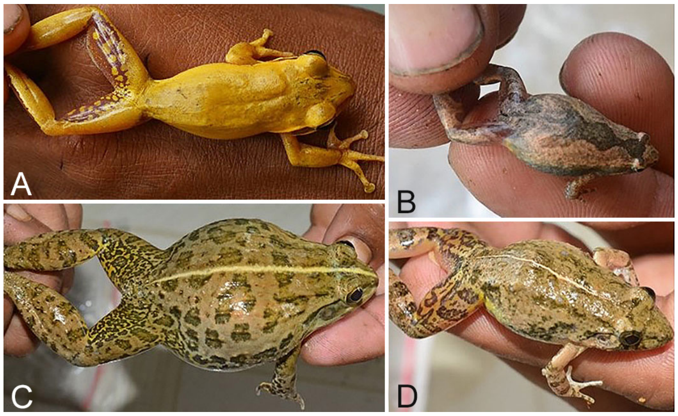

**Figure 7.** Amphibians recorded during surveys of agricultural land in Balasore District, Odisha, India: (A) Common Indian Treefrog (*Polypedates maculatus*); (B) Ornate Narrow-mouthed Frog (*Microhyla ornata*); (C) Indian Bullfrog (adult) (*Hoplobatrachus tigerinus*); (D) Cricket frog (*Fejervarya* sp.).

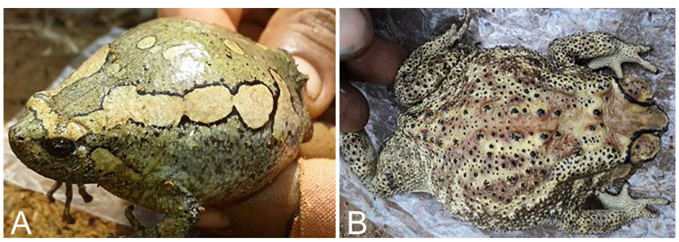

**Figure 8.** Amphibians recorded during surveys of agricultural land in Balasore District, Odisha, India: (A) Indian Painted Frog (*Uperodon taprobanicus*); (B) Common Indian Toad (*Duttaphrynus melanostictus*).

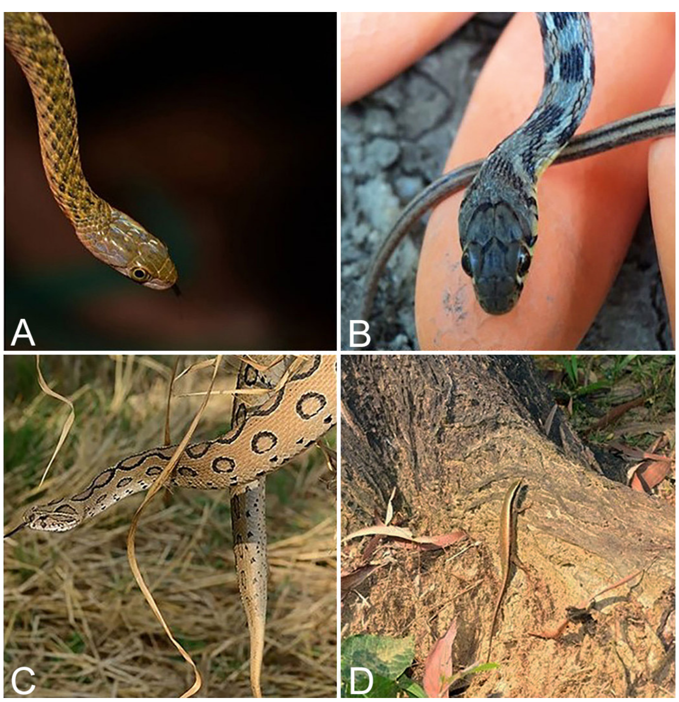

**Figure 9.** Reptiles recorded during surveys of agricultural land in Balasore District, Odisha, India: (A) Checkered Keelback (*Fowlea piscator*); (B) Buff-striped Keelback (*Amphiesma stolatum*); (C) Russell's Viper (*Daboia russelii*); (D) Bronze Skink (*Eutropis macularia*).

**Figure 10.** Reptiles recorded during surveys of agricultural land in Balasore District, Odisha, India: (A) Spectacled Cobra (*Naja naja*); (B) Indian Ratsnake (*Ptyas mucosa*); (C) Oriental Garden Lizard (*Calotes versicolor*); (D) Green Keelback (*Rhabdophis plumbicolor*).

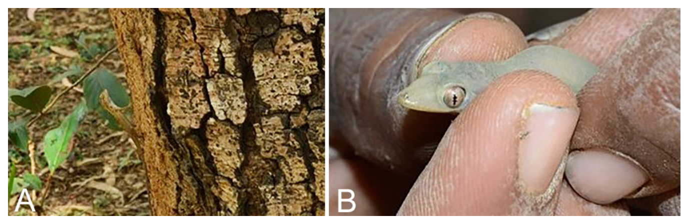

**Figure 11.** Reptiles recorded during surveys of agricultural land in Balasore District, Odisha, India: (A) Peninsular Dwarf Rock Agama (*Psammophilus blanfordanus*); (B) Yellow-green House Gecko (*Hemidactylus flaviviridis*).

Tortoise (*Geochelone elegans*) are listed as Near Threatened, Critically Endangered (CR), and Vulnerable, respectively. The remaining species are listed as being of Least Concern (LC) (IUCN 2024).

## Discussion

This study is the first attempt to formally document farmland herpetofaunal diversity by combining both ecological and community surveys. Although the ecological survey yielded a similar richness for amphibians and reptiles, the community survey documented more reptilian species than amphibians, especially snakes. This could be due to the prevalence of human/snake conflicts, which often lead to folklore and myths that increase familiarity with the species, whereas amphibians are cryptic and less harmful and might not pique the interest of farmers (Ghosh and Basu 2022). Another reason could be the heavy applications of pesticides, which have a greater impact on amphibians than reptiles (Ghosh 2023). The community survey showed that pesticide application has been a fairly common practice for decades and that the unregulated dosages can vary from as little as 8 ml/acre to more than 700 ml/acre.

Agricultural lands, especially paddy fields, have been considered hostile habitats for amphibians and reptiles (Biaggini and Corti 2015; Hansen et al. 2019). However, harboring 55 species indicates a potential suitability of agricultural habitats and clearly suggests that rice paddies should be seriously considered for their conservation value.

The biphasic life cycle of amphibians (an aquatic larval stage adapted for rapid growth and a terrestrial phase adapted for dispersal and reproduction) makes conservation challenging (Nolan et al. 2023). In the terrestrial environment, adult anurans select and colonize diverse habitat types for oviposition (Pelinson et al. 2016). Tadpoles inhabit different microhabitats, such as leaf litter, semi-permanent, permanent, and ephemeral pools, as well as seasonal and permanent streams or rivers, whereas reptiles are found mostly on the levees, trees, bushes, fallow lands, and within the paddies. Thus, water-saturated rice paddies and the adjoining habitats (e.g., sunny embankments, hedgerows, uncultivated uneven ground, buffer strips, rocky outcrops, woodland edges, etc.) found throughout agricultural lands can support a wide range of diversity (Halstead et al. 2019). Although considered a simple homogenized landscape compared to forests, agricultural lands are diverse, and have a potential to harbor species that needs to be reevaluated (Ghosh and Basu 2020).

Agricultural intensification is incessant and over 50% of global land contains some form of agriculture (Ellis 2015). Agriculture needs to recognize and increase its reliance on farmland biodiversity, which can provide valuable ecosystem services to help meet the growing demands of the human population and mitigate the decline of ecosystem health as a result of conventional agricultural practices. Developing strategies that safeguard biodiversity and optimize the ecosystem services provided by herpetofauna is critical. Rice paddies would benefit as they provide the key ecosystem service of crop-pest regulation (Ghosh and Basu 2023; Khatiwada et al. 2016; Monagan et al. 2017). Current conservation strategies should focus on creating ecosystem service-centric approaches that conserve both species and the services they provide (Ingram et al. 2012).

To my knowledge this report is the first effort at collating the herpetofaunal diversity of agricultural lands, specifically rice paddies. More studies need to document existing species in farmlands with different cropping systems for a complete understanding of the threats associated with various agricultural practices in order to realize the full conservation potential of agricultural habitats.

## Acknowledgements

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