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ENSURING THAT CLIMATE-SMART RICE CULTIVATION IS ALSO BIODIVERSITY-SMART

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Abstract: Irrigated rice fields often harbor important, overlooked biodiversity including globally threatened species. As surrogate wetlands (where the original natural wetlands have been lost), rice fields can support large numbers of migratory and resident birds, along with fish, frogs, crayfish, snails, and other aquatic species—many of which sustain local human livelihoods. Examples of rice cultivation with significant native biodiversity are found worldwide, in the temperate and tropical zones of developed as well as developing countries. Because flooded rice fields emit methane (a potent greenhouse gas), climate change mitigation efforts are now promoting climate-smart rice cultivation techniques, including alternate wetting and drying (AWD). AWD can reduce methane emissions while maintaining rice yields. However, the shorter ponding periods are unsuitable for many aquatic species; this can greatly reduce the biodiversity value of these rice fields. Since the world faces a biodiversity crisis along with a climate crisis, efforts to mitigate climate change should avoid biodiversity losses. Recommendations to make rice cultivation biodiversity-smart, as well as climate-smart, include (i) prioritizing biodiversity-friendly practices (including longer ponding periods) in rice fields located in or near Important Bird Areas, Ramsar Sites, and other areas of high biodiversity value; (ii) systematic biodiversity monitoring where AWD or other climate-focused rice cultivation changes are being tested; and (iii) biodiversity-smart adjustments to cultivation techniques, in response to the lessons learned from monitoring.

Author's Bio: Dr. George C. Ledec retired as World Bank Lead Ecologist in 2020 and now consults worldwide on biodiversity conservation, including biodiversity-friendly infrastructure and protected areas management. Dr. Ledec led the formulation and application of the World Bank's Natural Habitats Policy, which is now ESS6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources. His publications include *Greening the Wind*; *Good Dams and Bad Dams*; *Biodiversity Conservation in Road Projects*; and the *Biodiversity Offsets User Guide*. Dr. Ledec is also an avid eco-tourist and birder, having seen over 7,000 bird species in the wild. He is a naturalized United States citizen, born in what is now the Czech Republic. He resides with his wife Cathy in Cape Cod, Massachusetts.

Irrigated Rice Fields Produce More than Rice:

1. **Many irrigated rice fields are remarkably valuable for biodiversity.** Rice fields often host numerous species of birds (migratory and resident), along with fish, frogs, crayfish, snails, worms, aquatic insects, and other aquatic life. Recent research in California's Central Valley (USA) has found that at least 150 species of birds, 28 species of mammals, and 24 species of reptiles are known to inhabit flooded rice fields. Other examples of biodiversity-rich rice fields are found in every region where this crop is widely grown, including elsewhere in North America, South America, Europe, Africa, East and South Asia, and Australia. Rice fields with abundant birds and other biodiversity thus occur in developed and developing, tropical and temperate countries, around the world.

2. **Rice fields even provide a critical habitat for species of global conservation concern.** For example, about 40% of the world population of the Australasian Bittern *Botaurus poiciloptilus* (globally Endangered) has been found to breed in the rice fields of Riverina, New South Wales, Australia. These same rice fields also support the endemic Southern Bell Frog *Litoria raniformis*. Thousands of globally Vulnerable Hooded Cranes *Grus monacha* (about 90% of the world population) and White-naped Cranes *Antigone vipio* (about 50%) winter in the rice fields of Izumi, Kyushu, Japan. The coastal plain rice fields of Louisiana and east Texas (USA) have been identified as a critical spring migration stopover site for more than a million shorebirds, including over half the world population of the globally Near-threatened Buff-breasted Sandpiper *Calidris subruficollis*.

3. **Why is irrigated rice so important to wildlife?** Unlike most agricultural field crops, irrigated rice fields are **wetlands**. The international Ramsar Wetlands Convention defines wetlands to include human-created aquatic systems such as rice paddies, fishponds, and reservoirs. Where natural wetlands have been lost to agricultural or other development, irrigated rice fields function as surrogate wetlands, providing breeding or feeding areas for many (though not all) wetland-dependent species. At different stages of cultivation, rice fields can provide ideal conditions for wetland-based species that prefer open shallow water, mudflats, marsh, or wet prairie habitats. In drier regions, irrigated rice fields can serve as an oasis, with abundant water that attracts birds and other wildlife. One example of this "oasis effect" is the Mwea Irrigation Scheme in Kenya, with extensive rice paddies that attract large numbers of egrets, ducks, and other wetland-based birds.

4. **Rice fields with abundant biodiversity provide important benefits (besides rice) to local people.** Across South and East Asia and Africa, many local people harvest (sustainably or not) the fish, birds, small mammals, frogs, snails, and other aquatic animals from wet rice fields, enhancing their livelihoods and food security. Some rice fields are seasonally used for commercial aquaculture, such as for "crawfish" (crayfish) in Louisiana. Rice-growing areas in various countries have become an economically important focal point for different kinds of nature-based tourism. Madagascar's rice paddies attract birders from around the world to observe endemic, wetland-based species such as Meller's Duck *Anas melleri* (Endangered) and Madagascar Snipe *Gallinago macrodactyla* (Vulnerable). In Louisiana, the Yellow Rail and Rice

Festival enables hundreds of visiting birders each year to observe post-breeding Yellow Rails *Coturnicops noveboracensis* as they visibly fly in front of rice-harvesting machinery; these cryptic marsh birds are extremely difficult to see otherwise. Also in the United States, flooded rice-growing lands in winter provide for sustainable sport hunting of migratory ducks and geese in California, east Texas, Louisiana, and Arkansas. The town of Stuttgart, Arkansas promotes itself as "The Rice and Duck Capital of the World", where waterfowl hunting-related tourism generates millions of US dollars annually.

5. **Rice fields may abound in biodiversity, even when not managed for it**. Many prevailing practices associated with rice cultivation are decidedly not biodiversity-friendly. These include unregulated hunting and shooting; unsustainable harvest of fish and other aquatic life; bird-scaring devices and practices; and spraying of toxic pesticides and herbicides. Nonetheless, much biodiversity persists--even thrives—in rice fields with indifferent or hostile management practices. Of course, the most attractive rice fields to birds and other wildlife are those that are managed with biodiversity in mind.

Climate-Smart Rice Reduces Methane Emissions BUT May Threaten Biodiversity:

6. **Irrigated rice cultivation emits methane, a potent greenhouse gas.** Methane (CH_4) gas results from the decay of submerged organic matter in flooded rice fields. Methane from paddy rice cultivation accounts for about 1.5% of all global greenhouse gas (GHG) emissions (measured in CO_2 equivalents). Although this represents a very small fraction of total emissions, it is widely recognized that achieving adequate climate change mitigation will require all economic sectors (including rice cultivation) to reduce their carbon footprints wherever feasible.

7. **Irrigated rice is grown under widely varying conditions of water use control.** These range from natural seasonal flooding regimes to intensively managed paddy fields. More precise water control enables more intensive rice cultivation systems, including multiple crops per year in some regions. Aside from any concerns about methane emissions, irrigated rice farmers often seek to reduce water use because of its limited availability or high cost.

8. **In recent years, the concept of climate-smart agriculture (CSA) has been widely embraced by governments and international organizations.** CSA typically refers to agricultural systems or innovations that promote (i) sustainable increases in crop yields and farmer incomes; (ii) increased resilience of production systems (climate change adaptation); and (iii) reduced net GHG emissions (climate change mitigation).

9. **Climate-smart rice (CSR) techniques emphasize reducing methane emissions by shortening the ponding period** (the length of time that a rice field remains flooded, prior to being drained before harvest). CSR techniques include dry direct seeding, mid-season drainage, and alternate wetting and drying (AWD). AWD involves leaving a growing rice field wet, then dry, then wet again, and so on, for intervals of about one week each. In experimental trials, AWD has been found to reduce methane emissions, while maintaining rice yields per hectare. CSR cultivation, including AWD, is now being heavily promoted by governments and development

agencies, which envision “win-wins” of reduced greenhouse gas emissions and water use, without sacrificing yields or farmer incomes.

10. **CSR-driven ponding period reductions in rice fields are incompatible with the life cycles of many wetland-based species.** Rice field biodiversity greatly depends on water levels and their timing. The length of the ponding period determines habitat suitability for numerous wetland-dependent species. Where rice fields have been managed for shorter ponding periods including wet-dry fluctuations, biodiversity (when monitored) has markedly declined. For example, in Italy’s Po Valley, dry seeding of rice (which shortens the ponding period) has been documented to reduce bat feeding activity, along with amphibian densities and (as a result) nearby heron and egret breeding populations. Shorter ponding periods on many rice farms in Riverina, Australia (along with a switch from rice to cotton cultivation) now threaten the successful breeding of Australasian Bitterns.

11. **Assessing the biodiversity impacts of CSR needs to consider both (i) the rice field biodiversity and (ii) the effects of irrigation water abstraction on freshwater ecosystems.** If the irrigation water source maintains natural wetlands of high biodiversity value AND the water abstracted for rice cultivation threatens the extent or viability of these wetlands, then reducing rice field water consumption might provide a net gain for biodiversity. An example of natural wetlands that appear at risk from water abstraction for irrigated rice could be the Kilombero Valley in southern Tanzania; these wetlands harbor unique biodiversity, including three bird species found nowhere else on Earth (Kilombero Weaver *Ploceus burnieri*, Kilombero Cisticola *Cisticola bakerorum*, and White-tailed Cisticola *C. anderseni*). However, reducing water consumption in these rice fields will only assist the natural wetland biodiversity IF the water saved remains in the wetlands, rather than being sent elsewhere.

12. **In many areas, CSR cultivation methods that reduce water use (including AWD) are likely to reduce biodiversity, within the rice fields and overall.** If the source of rice field irrigation water is a large river or reservoir--where the water abstracted just for irrigated rice does not substantially affect the extent or viability of natural wetlands—then reducing rice field water consumption will likely result in a net loss for biodiversity. This scenario appears to be typical of irrigated rice-growing regions worldwide. As an example, in California, the winter flooding of harvested rice fields provides a critically important non-breeding habitat for literally millions of migratory waterfowl and shorebirds--this practice is now being challenged by CSR-inspired efforts to reduce the amount of time the fields are flooded.

Making Rice Cultivation Climate-Smart AND Biodiversity-Smart:

13. **The world faces a biodiversity loss crisis along with a climate change crisis.** A key challenge therefore is for CSR cultivation to reduce greenhouse gas emissions in ways that avoid seriously harming biodiversity. This same challenge is also faced in other sectors; for example, wind turbine facilities should be located, designed, and operated in ways that minimize bird and bat collisions. **To help mitigate climate change, CSR (including AWD) promotion and further innovation should continue, but in ways that duly recognize the biodiversity importance of irrigated rice-growing areas.**

14. **Recommendations to help make rice cultivation biodiversity-smart, as well as climate-smart, include:**

a. **Prioritizing biodiversity-friendly cultivation methods in rice-growing areas of high biodiversity value.** This means avoiding CSR techniques (including AWD) that would shorten rice field ponding periods in locations within or near Important Bird Areas, Ramsar Sites, protected areas, and other sites of recognized high biodiversity value. Other, complementary biodiversity-friendly rice cultivation practices to promote in areas of high biodiversity significance include (i) avoiding or minimizing any use of pesticides or other toxic agro-chemicals; (ii) effectively controlling any hunting, fishing, or other harvest of living natural resources in rice fields to sustainable, species-specific levels (except for non-native, invasive species); (iii) avoiding deliberate scaring or other disturbance to birds or other wildlife (except where needed to obtain viable rice harvests); (iv) keeping grassy or other vegetated banks around rice fields; (v) flooding post-harvest and fallow fields, especially during seasons of high waterbird use; (vi) providing small water-retention structures (excavated ditches) as a refuge for water-dependent organisms when rice fields go dry; and (vii) maintaining patches of freshwater marshes, ponds, or other natural wetlands within or adjacent to the rice-growing areas.

b. **Systematic biodiversity monitoring and adaptive management in areas where AWD or other CSR cultivation changes are being promoted or tested.** In projects that promote new or different cultivation techniques, it is routine to monitor changes in yields, farmer incomes, methane emissions, and water use. Changes in rice field biodiversity--especially species of conservation concern or special management interest--should similarly be monitored. This would advance scientific knowledge in the CSR field, which still faces a substantial learning curve. It would help predict the biodiversity impacts of scaling-up CSR practices over a wider rice-growing area. Most importantly, it would facilitate making biodiversity-smart adjustments to CSR cultivation techniques, in response to the lessons learned from monitoring. This would likely include the formulation or refinement of incentives for farmers to practice rice cultivation that is biodiversity-smart as well as climate-smart.

15. **The finding that irrigated rice fields often harbor important biodiversity has, to date, been overlooked by many agriculture and climate change specialists.** Efforts to reduce GHG emissions or water use in rice cultivation should not come at the expense of the migratory birds and other wetland-based species that now depend upon rice fields for their survival. **Environmental assessment professionals can help ensure that biodiversity impacts are adequately considered in projects and programs that affect rice cultivation.**

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