



Food and Agriculture
Organization of the
United Nations

NDC | THEMATIC
POLICY ANALYSIS



BIODIVERSITY AND AGRIFOOD SYSTEMS

in nationally determined contributions

ANNEX

ANNEX I

Table A. List of adaptation actions (grouped by sector system) included in the review, with the assessment of biodiversity impact and key references

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (number of countries)
Crop-based systems			
Climate tolerant crops and varieties	Possible risk or benefit Direct	Fu, 2015; Isbell et al., 2017; Kapazoglou et al., 2023; Njeru et al., 2022; Pörtner et al., 2021; Villanueva, Halewood and Noriega, 2017	76
Crop calendar optimization and rotation	Positive – well established Direct	Beillouin et al., 2021; Pörtner et al., 2021; Yu et al., 2022	8
Fire management	Possible benefit Indirect	Miralles-Wilhelm, 2021; Pörtner et al., 2021	2
Agroforestry and tree crops	Positive – well established Direct	FAO, 2019; Pörtner et al., 2021; Santos et al., 2022	45
On-farm soil and water moisture conservation	Positive – well established Direct	FAO, ITPS, GSBI, SCBD, and EC, 2021; FAO, 2017; Iqbal et al., 2020; Königer et al., 2021; Orgiazzi and Panagos, 2018; Pörtner et al., 2021	63
Irrigation and drainage	Possible risk or benefit Indirect	Drechsel, Marjani Zadeh and Pedrero, 2023; Grafton et al., 2018; Helmecke, Fries and Schulte, 2020; Pörtner et al., 2021; Tanneberger et al., 2022; Unesco, 2017; Yigezu et al., 2021	74
Water harvesting	Inconclusive/Unresolved	UNEP, 2009	36
Pest and disease management	Positive – well established Indirect	Beillouin et al., 2021; FAO, n.d.; Fenibo, Ijoma and Matambo, 2021; Pörtner et al., 2021; Vargas et al., 2022; Yu et al., 2022	33

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (number of countries)
Livestock-based systems			
Water infrastructure	Negative – well established Direct	Pörtner et al., 2021	12
Adapted animal breeds and species diversification	Possible risk or benefit Direct	Pörtner et al., 2021; Scherf and Pilling, 2015	46
Grazing and grassland management and restoration	Positive – well established Indirect	Alassan, Ibrahim and Marcel, 2017; McDonald et al., 2019; Pörtner et al., 2021; Ravetto Enri et al., 2017; Rossiter et al., 2017; Tanneberger et al., 2022	47
Agro-silvo-pastoralism	Positive – well established Direct	Cárdenas et al., 2019; FAO, 2017	25
Feed and forage management	Possible benefit Indirect	Kenny et al., 2018	31
Manure management	Possible benefit Indirect	De Vries et al., 2015; Karimi et al., 2022	12
Animal husbandry	Inconclusive/Unresolved		31
Forestry-based systems			
Sustainable forest management	Positive - well established	Dresen et al., 2014; Harrison et al., 2022; Pörtner et al., 2021	73
Reducing deforestation and forest conservation	Positive – well established Direct	Dresen et al., 2014; Pörtner et al., 2021	55
Adapted forest species and genetic diversification	Possible risk or benefit Direct	Huang et al., 2018; Pörtner et al., 2021; Pötzelsberger et al., 2020	10
Afforestation, reforestation and forest and landscape restoration	Possible benefit Direct	Harrison et al., 2020, 2022; Pörtner et al., 2021	81
Wild-fire prevention and integrated management	Possible benefit Indirect	Miralles-Wilhelm, 2021; Pörtner et al., 2021	20
Non-timber wood products	Possible risk or benefit Direct	Dao and Hölscher, 2018; Sunderland, Ndoye and Harrison-Sanchez, 2011; Zhang et al., 2021	16
Pest and disease management	Positive – well established Indirect	Kenis et al., 2019; Vargas et al., 2022	5

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (number of countries)
Fisheries and aquacultural systems			
Adaptive capture fishing practices and technologies	Possible risk or benefit Indirect	Beckensteiner, Boschetti and Thébaud, 2023; Das, Sarkar and Roy, 2019; FAO, n.d.; Pörtner et al., 2021; Woods et al., 2022	31
Sustainable fisheries practices	Positive – well established Indirect	Gaines et al., 2018; Himes-Cornell et al., 2022; Kennon et al., 2023; Pörtner et al., 2021	41
Improved water management to sustain fishery services	Possible risk or benefit Indirect	FAO, n.d.; McCartney, Funge-Smith and Kura, 2018	3
Safety at sea	Neutral		6
Aquaculture feed management	Positive – well established Indirect	Kause, Nousiainen and Koskinen, 2022	2
Aquaculture farm site selection and infrastructure	Possible risk or benefit Indirect	Arias et al., 2019; Barange et al., 2018; Miralles-Wilhelm, 2021; Theuerkauf et al., 2019	14
Aquaculture water management	Positive – well established Indirect	Boyd et al., 2020; Cottrell et al., 2018	7
Aquaculture species selection and selective breeding	Possible risk or benefit Indirect	Lothmann and Sewilam, 2023; Miralles-Wilhelm, 2021; Pörtner et al., 2021	20
Post-harvest food system and supply chain infrastructure			
Improved post-harvest practices	Enabling condition	Pörtner et al., 2021	47
Productive infrastructure and equipment	Possible risk Indirect	FAO, n.d.; Kansanga et al., 2020; Pörtner et al., 2021	90
Food loss and waste reduction	Enabling condition	Pörtner et al., 2021	4
Agricultural wastewater management	Possible benefit Indirect	Helmecke, Fries and Schulte, 2020; Mahjoub et al., 2022; Pörtner et al., 2021	21
Agricultural waste management	Positive - well established Indirect	Koul, Yakoob and Shah, 2022; Kumar and Singh, 2021; Wu and Ma, 2015	13
Value addition and markets	Inconclusive/Unresolved	Tacconi et al., 2022	58

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (number of countries)
Energy in agri-food systems			
Bioenergy	Possible risk Direct	FAO, 2012; Pörtner et al., 2021; Tudge, Purvis and De Palma, 2021	24
Improved energy use in agri-food systems	Inconclusive/Unresolved		30
Energy access to rural areas	Negative – well established Direct	Biasotto and Kindel, 2018; Niebuhr et al., 2022	7
Ecosystem			
Conservation	Positive – well established	FAO, 2019; Pörtner et al., 2021	115
Management			110
Restoration			87
Conservation, management and restoration	Direct		107
Water			
Water-related management in agriculture	Possible risk or benefit Indirect	Li et al., 2018; Orgiazzi and Panagos, 2018; Pörtner et al., 2021	89
WaSH-related adaptation in agrifood systems and rural areas	Neutral		65
Flood risk reduction in rural and vulnerable areas	Possible risk or benefit Direct	Pörtner et al., 2021; Wu et al., 2019	70
Riparian habitat or Wetland restoration	Positive – well established Direct	Pörtner et al., 2021	11
Integrated water resources management	Positive – well established Indirect	Abell et al., 2017; Pörtner et al., 2021	105
Wastewater treatment and reuse of non-conventional sources	Possible risk or benefit Indirect	Helmecke, Fries and Schulte, 2020; Mahjoub et al., 2022; Pörtner et al., 2021	28
Adaptation of the cultural water uses of indigenous peoples	Positive – well established Indirect	CBD, 2016	8

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (number of countries)
Food security & nutrition			
Changing dietary patterns	Enabling condition	Carey et al., 2023; Pörtner et al., 2021	9
Multi-sectoral approaches for food security and nutrition	Neutral		73
Health and wellbeing			
Health strategies, policies and interventions	Neutral		62
Adaptive migration	Possible risk Indirect	Carr, 2009; Cripps and Gardner, 2016; López-Feldman and Chávez, 2017; Oglethorpe et al., 2007; Ospina, Peterson and Crépin, 2019	24
Reducing conflict risks	Enabling conditions	Rüttinger et al., 2021	6
Poverty, livelihoods and inequality			
On- and off-farm livelihood diversification	Inconclusive/Unresolved	Ahmadzai, 2020; Isbell et al., 2017; Pörtner et al., 2021	68
Access to finance, savings and credit	Inconclusive/Unresolved	Tacconi et al., 2022	23
Subsidies	Possible risk or benefit Indirect	McElwee et al., 2020; Pörtner et al., 2021; Springmann and Freund, 2022	10
Payment for ecosystem services	Possible benefit Indirect	Chen et al., 2020; Salzman et al., 2018	9
Social networks and member organisations	Inconclusive/Unresolved	Tacconi et al., 2022	15
Land and water tenure reform	Inconclusive/Unresolved	UN, 2021b; Robinson et al., 2018; Schürmann et al., 2020	10
Community-based adaptation	Inconclusive/Unresolved		24
Social protection	Inconclusive/Unresolved		22
Insurance	Neutral		42

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (number of countries)
Critical urban-rural infrastructure and services			
Land use planning	Possible benefit Indirect	Cohn and Lerner, 2003; Di Pirro et al., 2021; Fastré et al., 2021	41
Climate-proofed physical infrastructure in cities and peri-urban areas	Negative – well established Direct	Juffe-Bignoli et al., 2021; Pörtner et al., 2021	86
Green and blue and green-grey infrastructure in urban areas	Positive – well established Indirect	Bel Fekih Boussema, Cohen and Khebour Allouche, 2022; Donati et al., 2022; Livesley, Escobedo and Morgenroth, 2016; Royer, Yengue and Bech, 2023	35
Protect urban shorelines	Possible risk or benefit Direct	Gittman et al., 2016; Guerry et al., 2022; Martins et al., 2016; Moraes et al., 2022	19
Urban and peri-urban agriculture	Positive Indirect	Oh and Lu, 2023; Pörtner et al., 2021; Royer, Yengue and Bech, 2023; Stein, 2021	13
Urban and peri-urban forestry	Positive Indirect	Livesley, Escobedo and Morgenroth, 2016; Pörtner et al., 2021	18

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (number of countries)
Gender and equality			
Empowerment and participation in decision-making	Enabling conditions	Alvarez and Lovera, 2016; Boyer and Granat, 2021; FAO, 2023; Lau, 2020; Tacconi et al., 2022	30
Building skills of women and marginalized groups to adopt new technologies and practices	Neutral		48
Promotion of local, traditional and indigenous knowledge	Positive – well established Indirect	CBD, 2016; Gadgil, Berkes and Folke, 1993; Tacconi et al., 2022	32
Reducing underlying inequalities	Enabling conditions	CBD, 2016	31
Risk management and coping capacity	Neutral		45
Economic inclusion	Enabling conditions	CBD, 2016	54
Gender/inclusivity mainstreaming in policies and budgets	Enabling conditions	Alvarez and Lovera, 2016; Boyer and Granat, 2021; Lau, 2020	39

Table B. List of mitigation actions (grouped by sector system) included in the review, with the assessment of biodiversity impact and key references

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (count of countries)
Crop and cropland systems			
Crop nutrient and tillage management	Possible benefit Direct	Beillouin et al., 2021; Frøslev et al., 2022; Librán-Embid et al., 2020; Liu et al., 2024; Pörtner et al., 2021; Yu et al., 2022	69
Improved rice management	Inconclusive/Unresolved	Li et al., 2018; Wang et al., 2020	36
Crop management	Possible benefit Direct	Beillouin et al., 2021; Isbell et al., 2017; Pörtner et al., 2021; Yu et al., 2022	61
Reduced crop residue burning	Inconclusive/Unresolved	Aryal et al., 2022; Sahai et al., 2011; Thakur et al., 2021; Wu and Zhang, 2018	14
Water management in croplands	Possible risk or benefit Indirect	Pörtner et al., 2021	33
Agroforestry and tree crops	Positive – well established Direct	FAO, 2019; Pörtner et al., 2021; Santos et al., 2022	55
Biochar	Inconclusive/Unresolved	Gao et al., 2022; Ortiz-Liévana et al., 2023; Wang et al., 2022, 2023	1
Livestock and grassland systems			
Manure management	Inconclusive/Unresolved		49
Livestock breeding and husbandry	Inconclusive/Unresolved	FAO, 2019	28
Livestock feed management	Inconclusive/Unresolved		30
Grassland and herd management	Possible benefit Direct	Hoekstra et al., 2023; Yoshihara, Furusawa and Sato, 2016	18
Agro-silvo-pastoralism	Positive – well established Direct	Cárdenas et al., 2019; FAO, 2017	21
Reduce savanna burning	Possible benefit Indirect	Miralles-Wilhelm, 2021; Pörtner et al., 2021	6
Animal management	Positive – well established Direct	Bengtsson et al., 2019; Fraser, Vallin and Roberts, 2022; Gornish et al., 2018; Piipponen et al., 2022	18
Grassland conservation restoration	Positive – well established Direct	Pörtner et al., 2021	15

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (count of countries)
Reduce degradation and conversion of grasslands and savanna	Positive – well established Direct	Pörtner et al., 2021	3
Forest systems			
Reduce deforestation and degradation	Positive – well established Direct	Pörtner et al., 2021	93
Afforestation, reforestation and forest ecosystem restoration	Possible benefit Direct	FAO, IUCN CEM and SER, 2021; FAO, SER and IUCN CEM, 2023; Harrison et al., 2020; Pörtner et al., 2021	110
Improve forest management	Positive - well established	Harrison et al., 2022; Pörtner et al., 2021; Roberge et al., 2018	87
Reduce forest fires	Possible benefit Indirect	Miralles-Wilhelm, 2021; Pörtner et al., 2021	23
Wetlands			
Reduce degradation and conversion of coastal wetlands	Positive – well established Direct	Pörtner et al., 2021	28
Coastal wetlands restoration	Positive – well established Direct	FAO, IUCN CEM and SER, 2021; FAO, SER and IUCN CEM, 2023; Pörtner et al., 2021	21
Wetlands restoration	Positive – well established Direct	FAO, IUCN CEM and SER, 2021; FAO, SER and IUCN CEM, 2023; Pörtner et al., 2021	2
Reduce degradation and conversion of peatlands	Positive – well established Direct	Pörtner et al., 2021	7
Peatland restoration	Positive – well established Direct	FAO, IUCN CEM and SER, 2021; FAO, SER and IUCN CEM, 2023; Pörtner et al., 2021	8
Fisheries and aquacultural systems			
Aquaculture feed and water management	Positive – well established Indirect	Boyd et al., 2020; Cottrell et al., 2018; Kause, Nousiainen and Koskinen, 2022	5

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (count of countries)
Multiple ecosystems			
Protect ecosystems	Positive – well established Direct	FAO, 2019; FAO, SER and IUCN CEM, 2023; Pörtner et al., 2021	29
Manage ecosystems			10
Restore ecosystems			20
Protect, manage and restore ecosystems			10
Urban systems			
Urban agriculture and green roofs	Positive - well established Direct	Pörtner et al., 2021; Royer, Yengue and Bech, 2023	2
Urban forests	Positive - well established Direct	Livesley, Escobedo and Morgenroth, 2016; Pörtner et al., 2021	21
Energy in agri-food systems			
On-farm energy use	Negative – well established Direct	Biasotto and Kindel, 2018; Niebuhr et al., 2022	31
Improved food processing and packaging	Inconclusive/Unresolved		10
Improved food storage and distribution	Possible benefit Indirect	Canfora, 2016	6
Fertilizer manufacturing and other pre-production	Inconclusive/Unresolved		1
Bioenergy from agricultural biomass	Possible risk Direct	Blanco-Canqui, 2016; Dauber and Miyake, 2016; Donnison et al., 2021; FAO, 2012; Hanssen et al., 2022; Núñez Regueiro, Siddiqui and Fletcher, 2021; Pörtner et al., 2021; Tudge, Purvis and De Palma, 2021	54
Bioenergy from forest biomass	Possible risk Direct	FAO, 2012; Pörtner et al., 2021; Repo et al., 2020	56
Bioenergy from non-specified biomass	Possible risk Direct	FAO, 2012; Hanssen et al., 2022; Tudge, Purvis and De Palma, 2021; Verdade, Piña and Rosalino, 2015	28

Action	Assessment of biodiversity impact	Key references	Inclusion in NDCs (count of countries)
BECS	Possible risk Direct	Blanco-Canqui, 2016; Dauber and Miyake, 2016; Donnison et al., 2021; Hanssen et al., 2022; Tudge, Purvis and De Palma, 2021	0
Demand-side of agri-food systems			
Shift to sustainable healthy diets	Enabling condition	Carey et al., 2023; Pörtner et al., 2021	9
Reduce food loss and waste	Enabling condition	Pörtner et al., 2021	16
Ecotourism	Possible risk or benefit	Brandt and Buckley, 2018; Pörtner et al., 2021; Shannon et al., 2017; Stronza, Hunt and Fitzgerald, 2019	7
Improved and enhanced use of wood products	Possible risk	Leaver and Cherry, 2020; Pörtner et al., 2021; Venn, 2023	4
Waste in agri-food systems			
Agricultural waste management	Positive - well established Indirect	Koul, Yakoob and Shah, 2022; Kumar and Singh, 2021; Wu and Ma, 2015	43
Agricultural wastewater management	Inconclusive/Unresolved	Duan et al., 2020; Yao et al., 2020	10

ANNEX II

The criteria for classification of impact has been aligned with criteria and terminology utilised in the IPBES Guide on the Production of Assessments (IPBES, 2018) and the IPBES-IPCC co-sponsored workshop on biodiversity and climate change (Pörtner *et al.*, 2021).

Table A. Classification criteria for biodiversity impact attribution

Classification	Criteria
Positive - well established	Over 90% of literature reviewed relating to the specific action indicates positive impact.
Possible benefit	Over two-thirds of literature reviewed relating to the specific action indicates positive impact, but that specific practices are needed to generate positive impact, and less than a third suggests a negative or neutral impact.
Possible risk or benefit	At least a third of papers review suggest positive/negative and the rest of papers review suggest the opposite. Alternatively, the action tag as described in the protocol contains multiple specific actions, some of which as biodiversity positive, and some of which are biodiversity negative.
Possible risk	Over two-thirds of literature reviewed relating to the specific action indicates negative impact and less than a third suggest a positive or neutral impact.
Negative – well established	Over 90% of literature reviewed relating to the specific action indicates negative impact.
Enabling conditions	Over 90% of literature reviewed relating to the specific action indicates that the action facilitates biodiversity gain, or removes an indirect driver.
Neutral	There is no evidence, either through published literature or theories, that the action has a direct or indirect impact on biodiversity, nor create enabling conditions.
Inconclusive /Unresolved	There is no conclusive scientific evidence that the action has an impact of biodiversity, but there are theories (or speculation) of potential impact that need to be explored further in literature.

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