



Global knowledge & use of soil biodiversity: Lessons from a worldwide survey

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Embrapa + many others



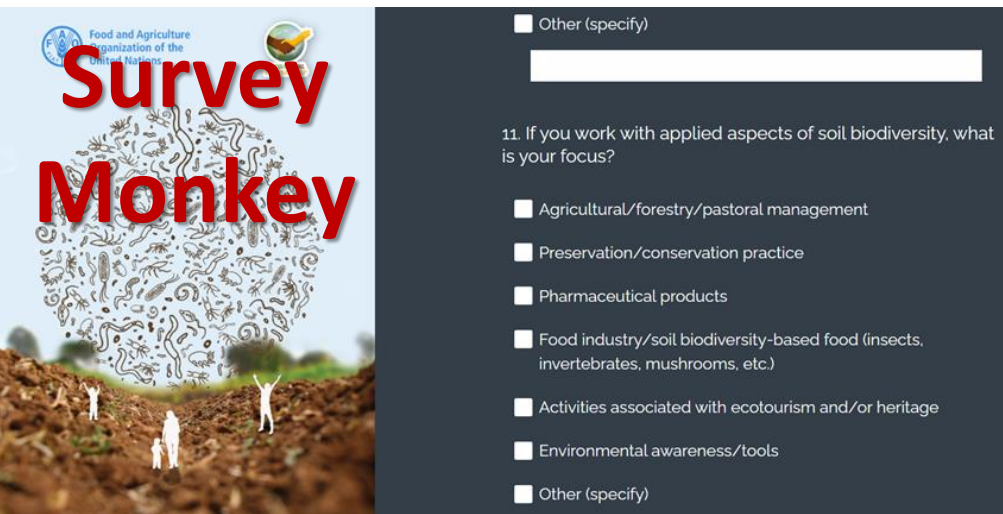
GLOBAL
SOIL BIODIVERSITY
INITIATIVE



Global Soil Biodiversity Survey (8-29 March 2022)

70K e-mails,
2696 replies (< 4%)
122 questions

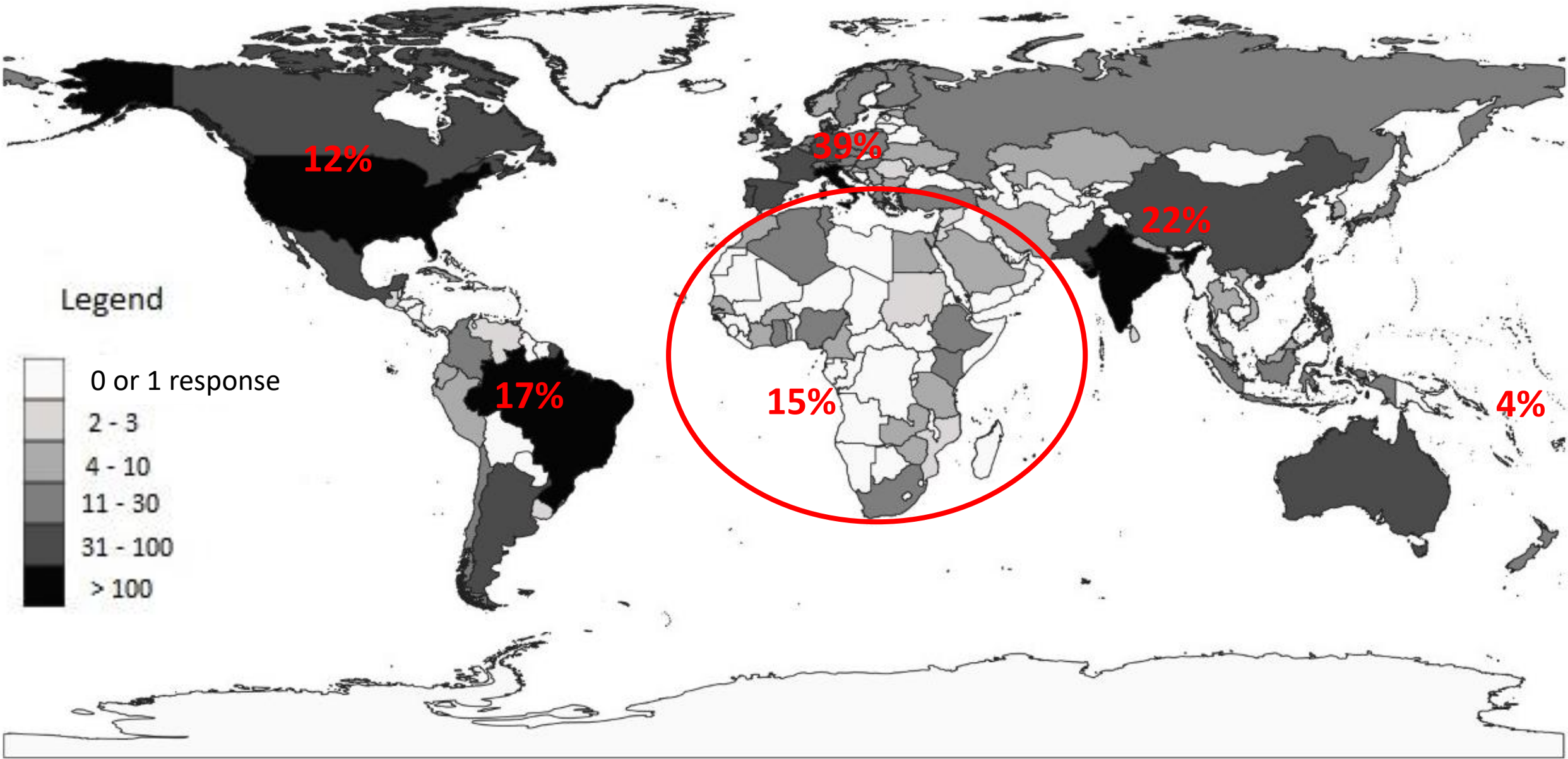
1. General information
2. Microbes and microbial activity
3. Microfauna (including Protists)
4. Mesofauna
5. Macrofauna
6. Megafauna
7. Community level/functional assessments of soil biodiversity
8. Soil biodiversity inventory/monitoring activities
9. Ecosystem services, applications, and threats to soil biodiversity
10. Education/Communication activities
11. Public policies related to soil biodiversity



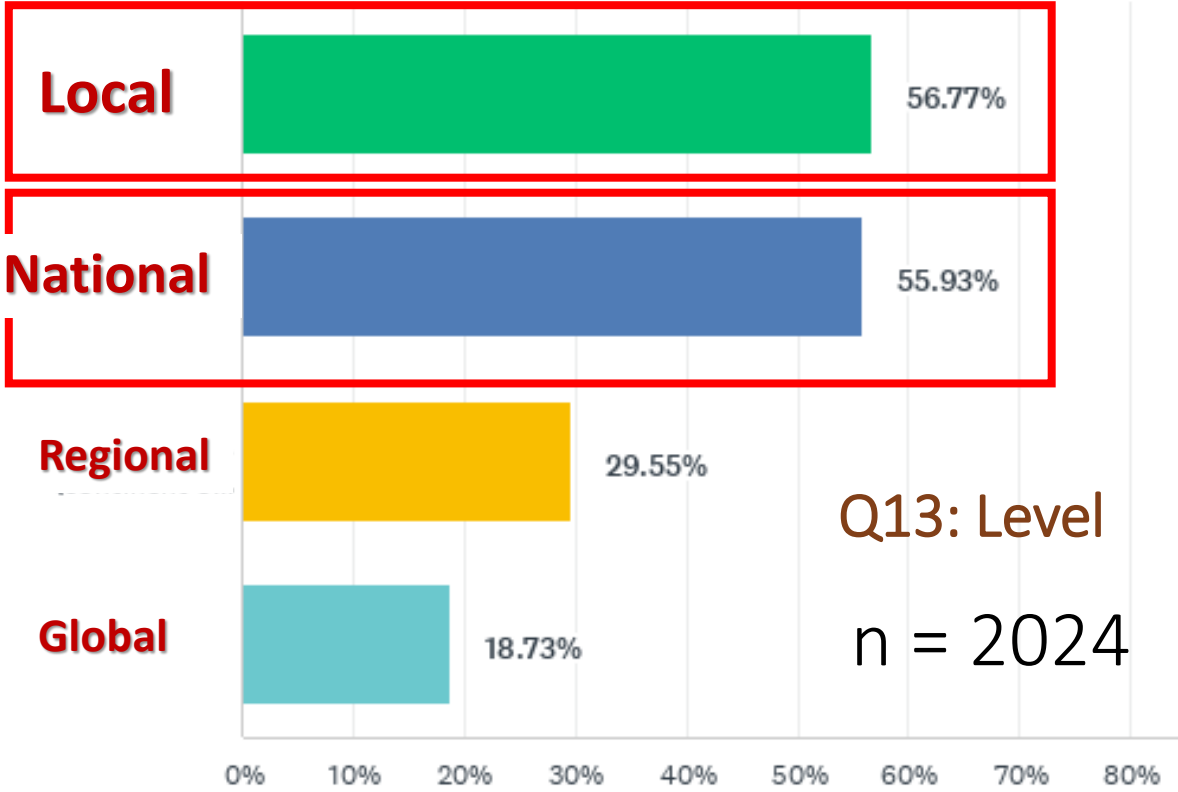
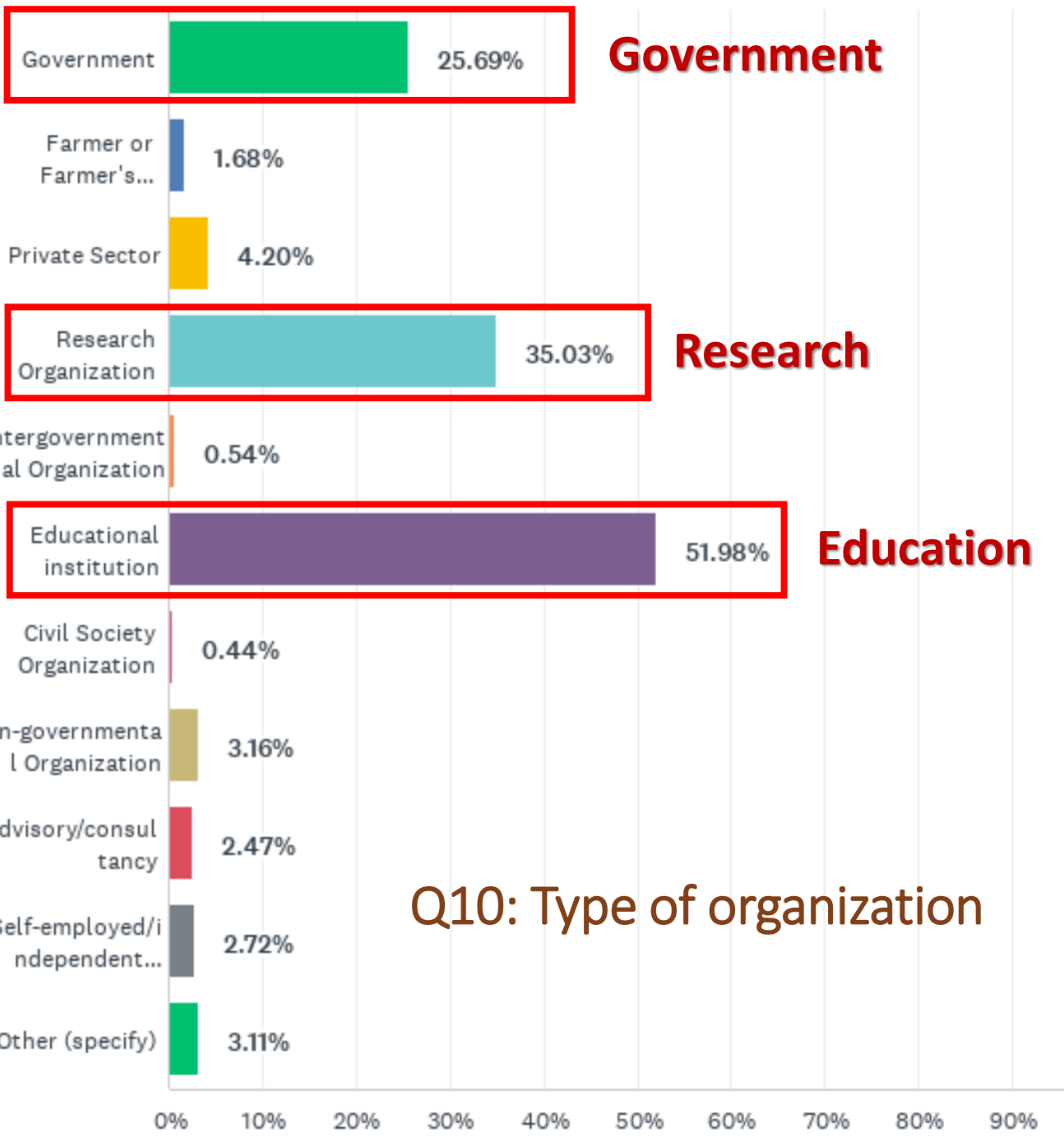
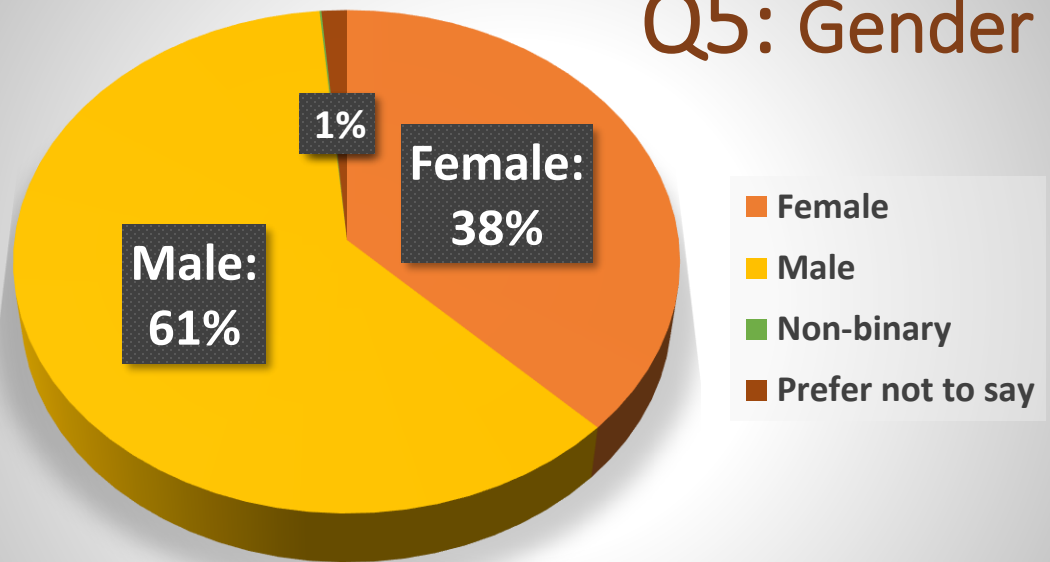
Main Objective: State-of-the-art assessment of knowledge on soil biodiversity work worldwide

- Identify main stakeholders in soil biodiversity work worldwide
 - Who is doing what, where & how?
 - e.g., inventories, monitoring, mapping, databases
- Information on specific taxa & functions of soil biota
- Reveal the main methods used to study soil biota
- Assess main uses of soil biota worldwide
- Evaluate work on ecosystem services & valuation methods
- Verify presence of & knowledge on public policies related to soil biodiversity

Responses: 139 countries, >1350 institutions



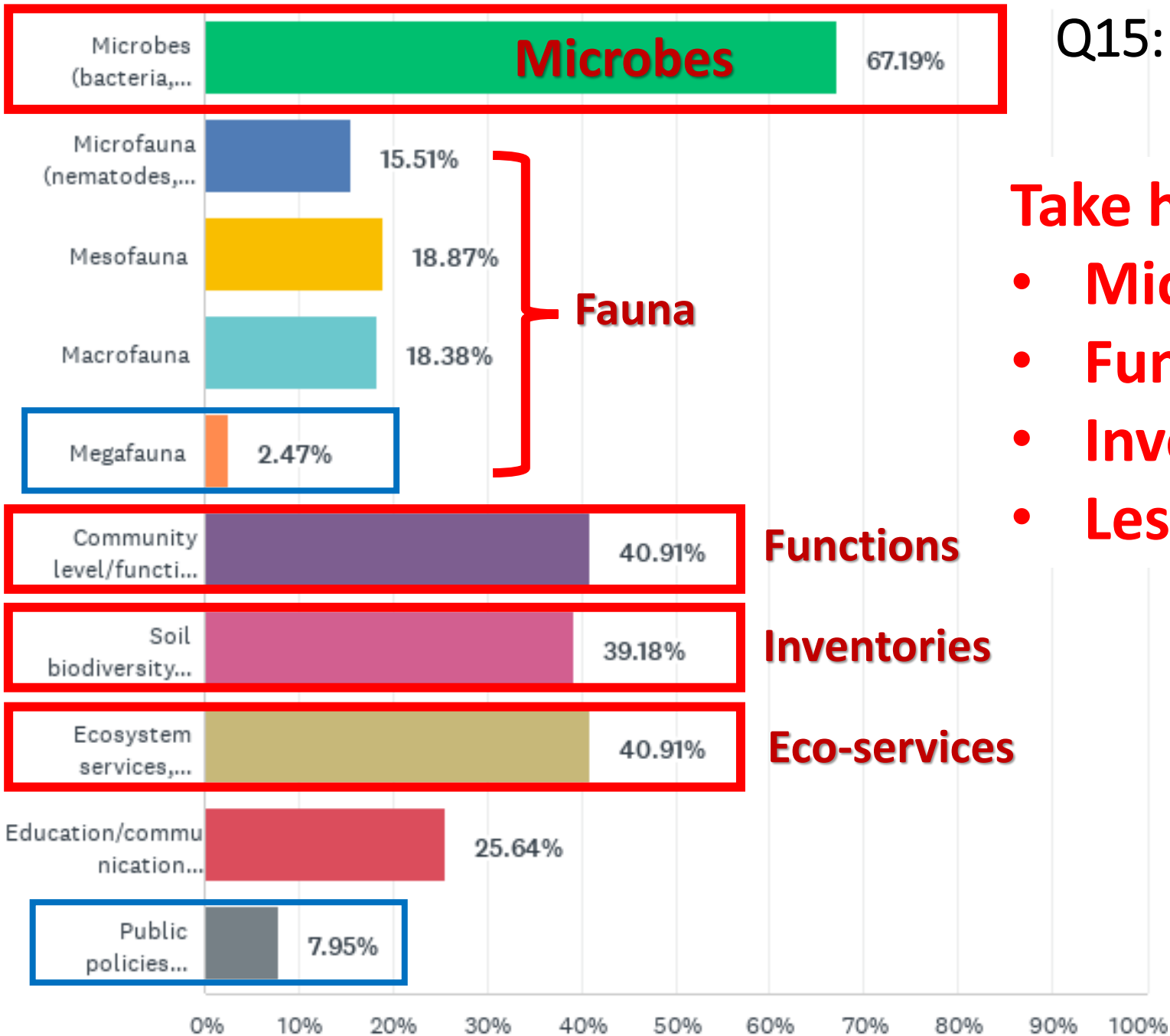
Q5: Gender



Q13: Level
n = 2024

Q10: Type of organization

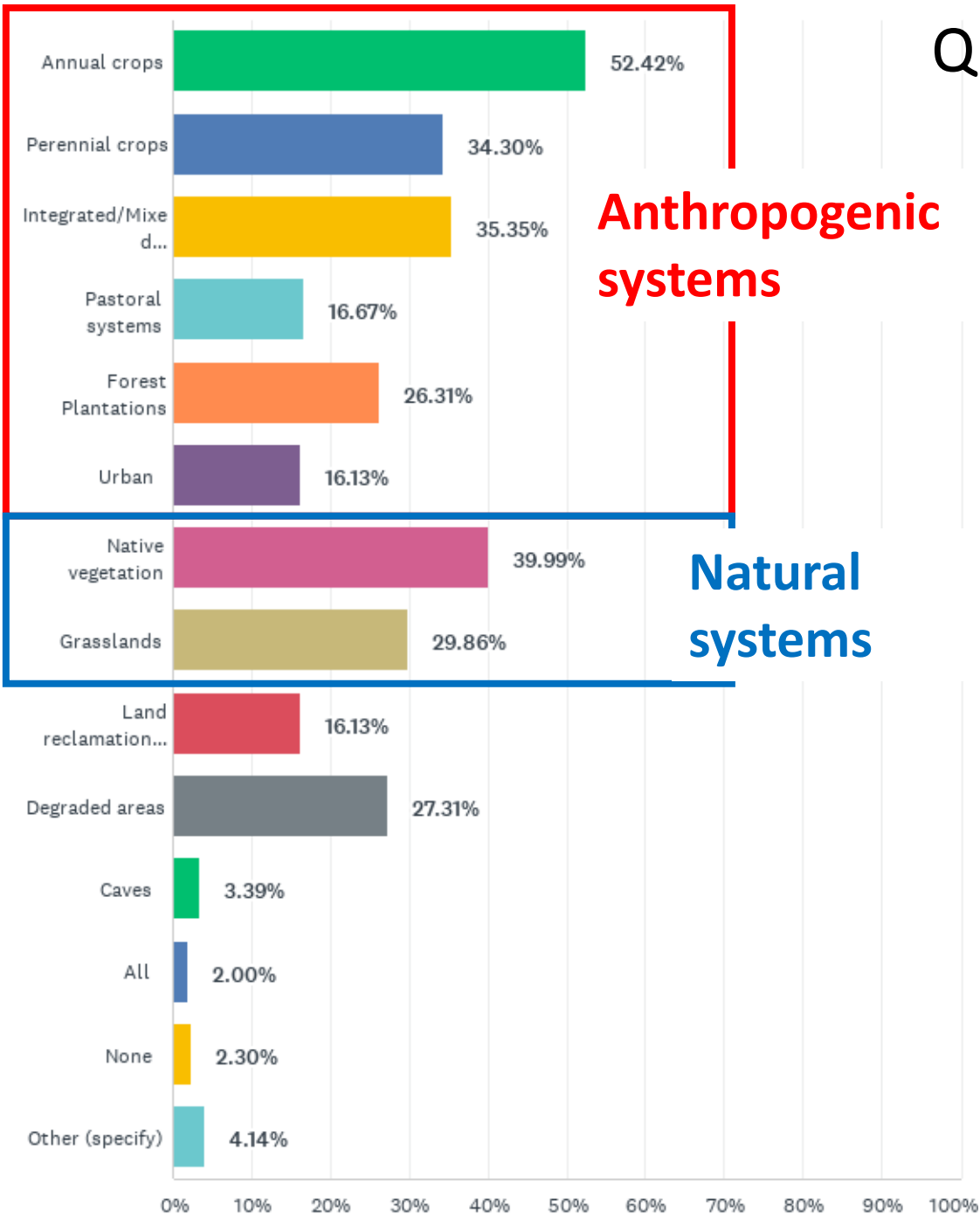
Q15: Main themes & groups of biota



Take home:

- **Microbes dominate (68%)**
- **Functional/uses (41%)**
- **Inventories (40%)**
- **Less attention fauna (2-19%)**

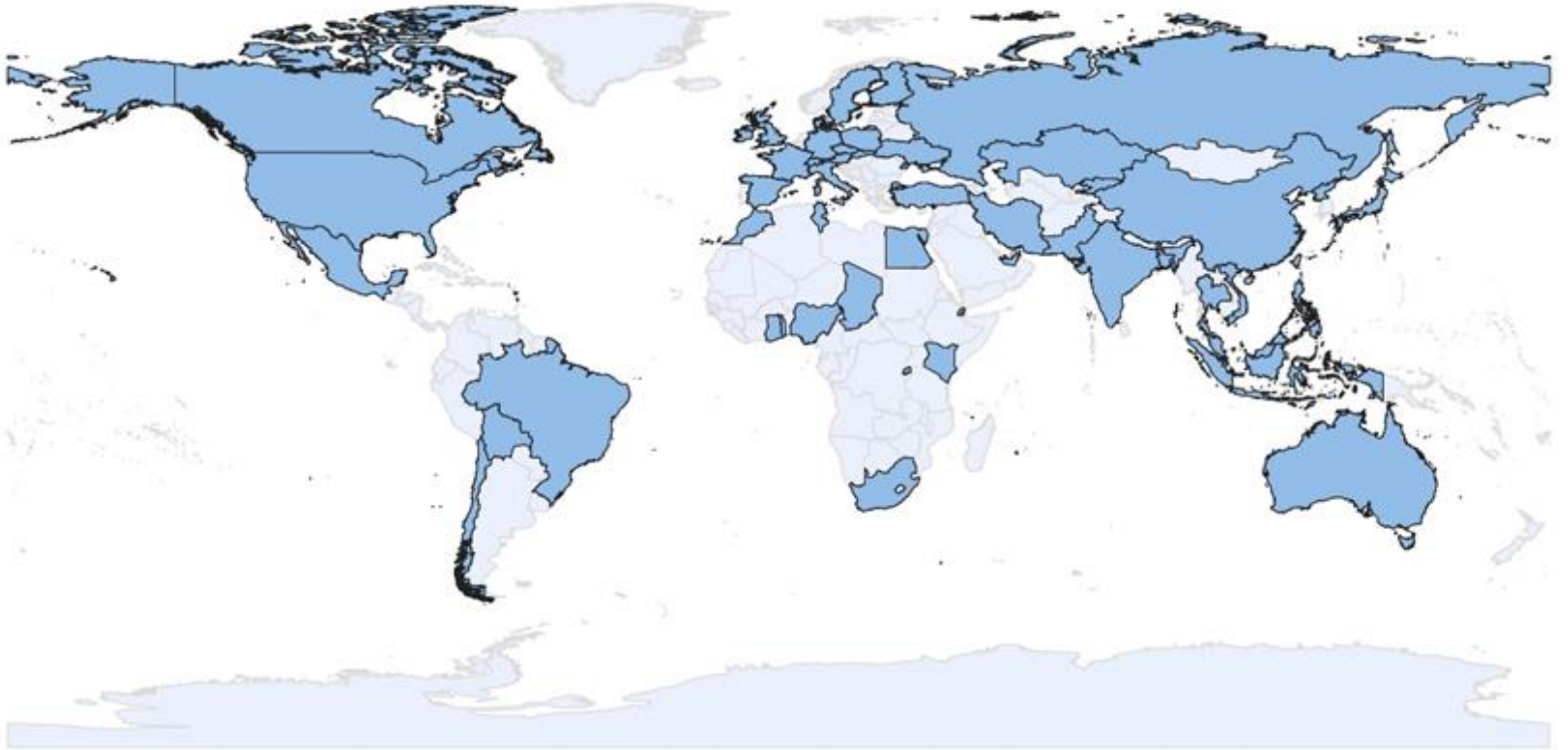
Q14: Main land covers studied



Take home:

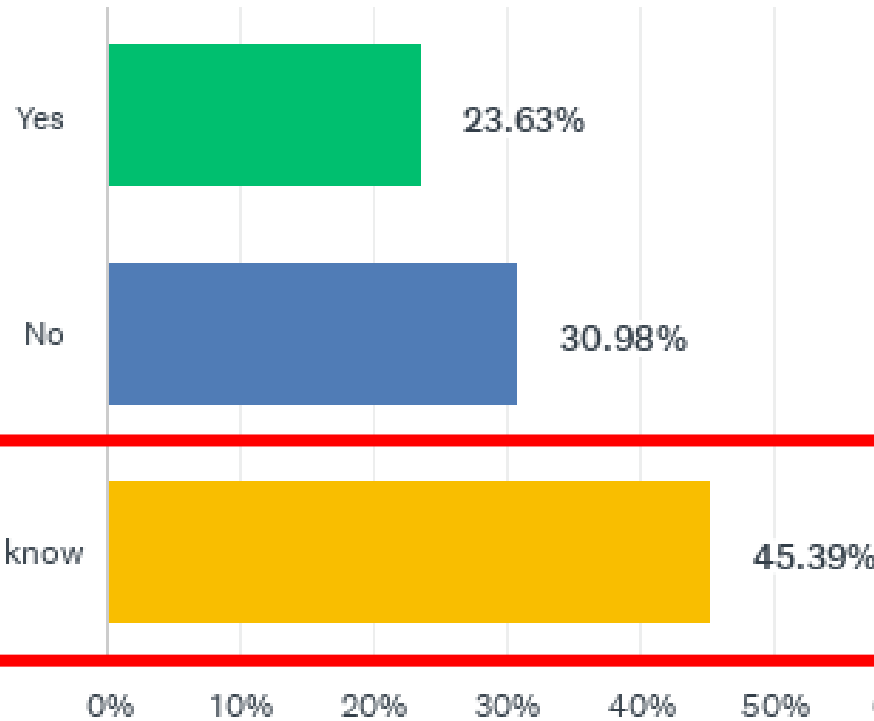
- Crops dominate (34-52%)
- Natural systems as reference (30-40%)
- Degraded lands, Forest plantations (~25%)
- Few urban, pastoral, reclaimed sites (16%)

50 countries have soil biodiversity inventories (at any level & taxa)

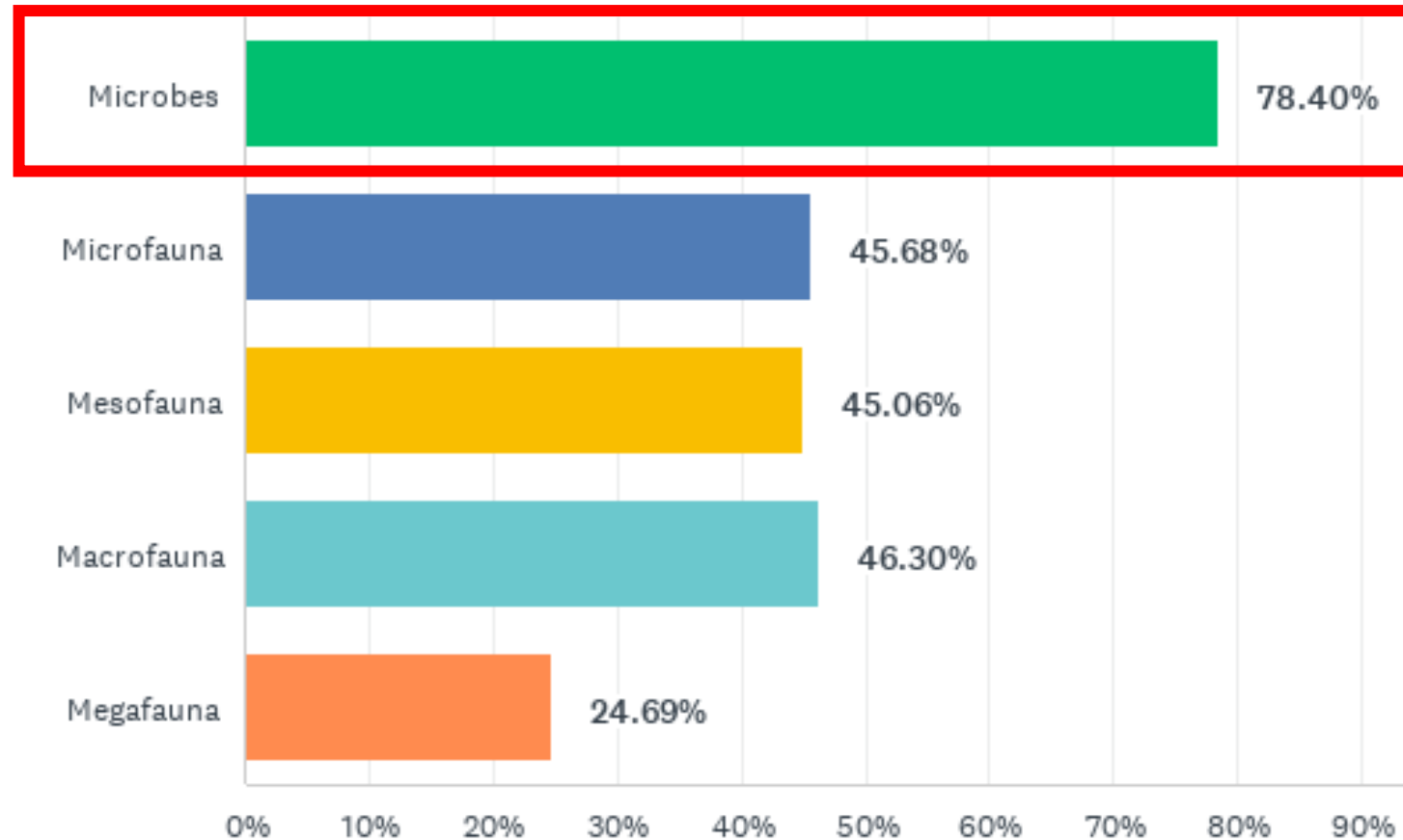


Take home:

- Low awareness of national inventories
- Microbes dominated (78%), less attention fauna (25-46%)

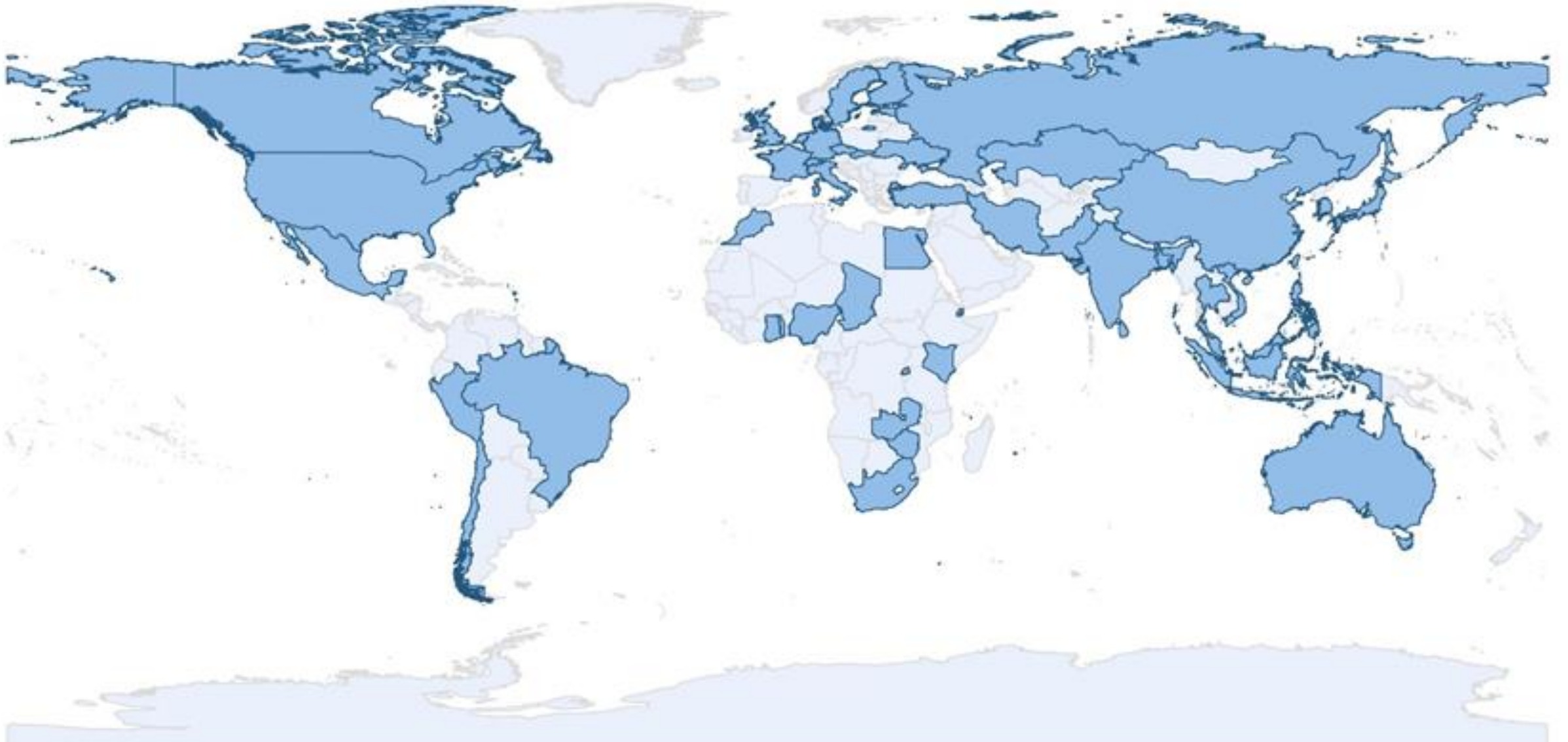


Q91: National inventories including soil biodiversity

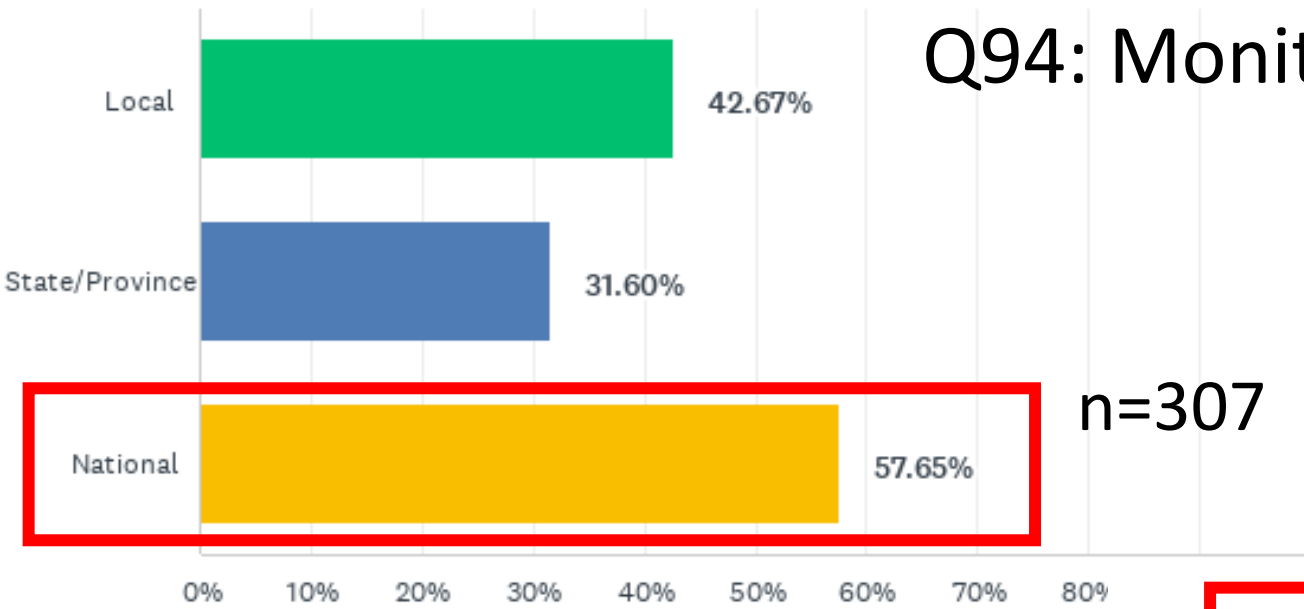


Q92: Main groups of organisms included

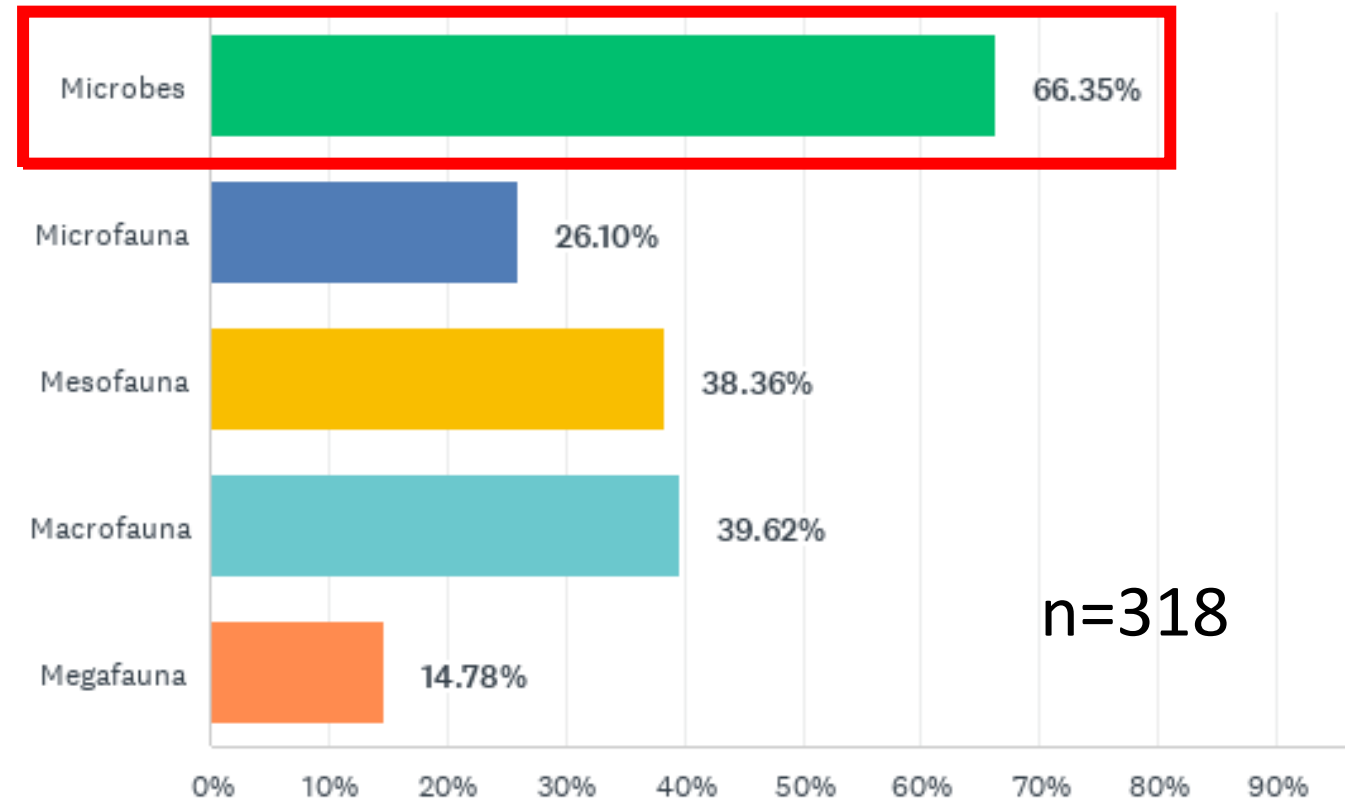
48 countries have monitoring programs
(at any level & taxa)



Q94: Monitoring level...



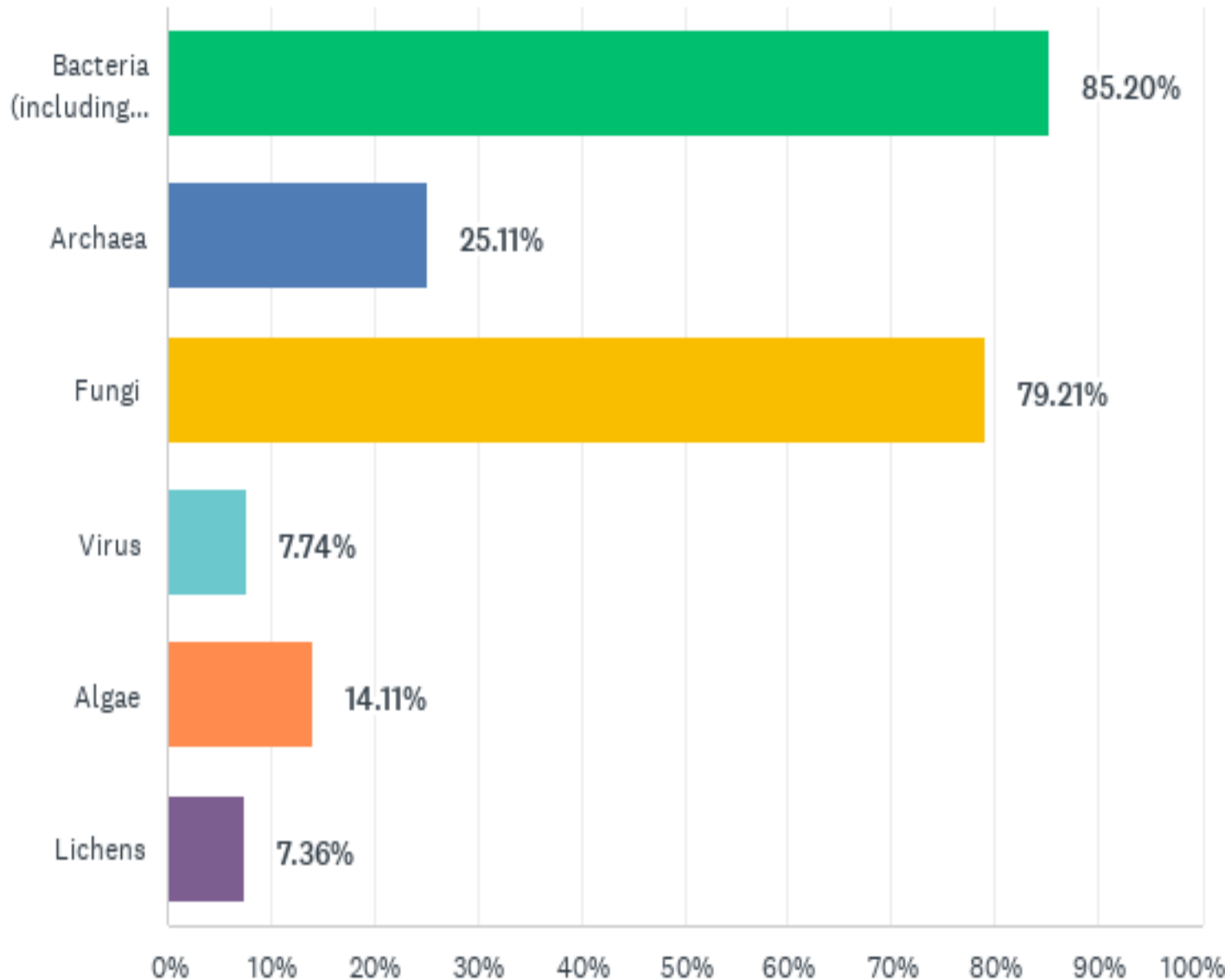
Q95: Taxa monitored...



Take home:

- **Mostly National or Local monitoring**
- **Microbes dominate (66%)**
- **Less attention fauna (15-40%)**

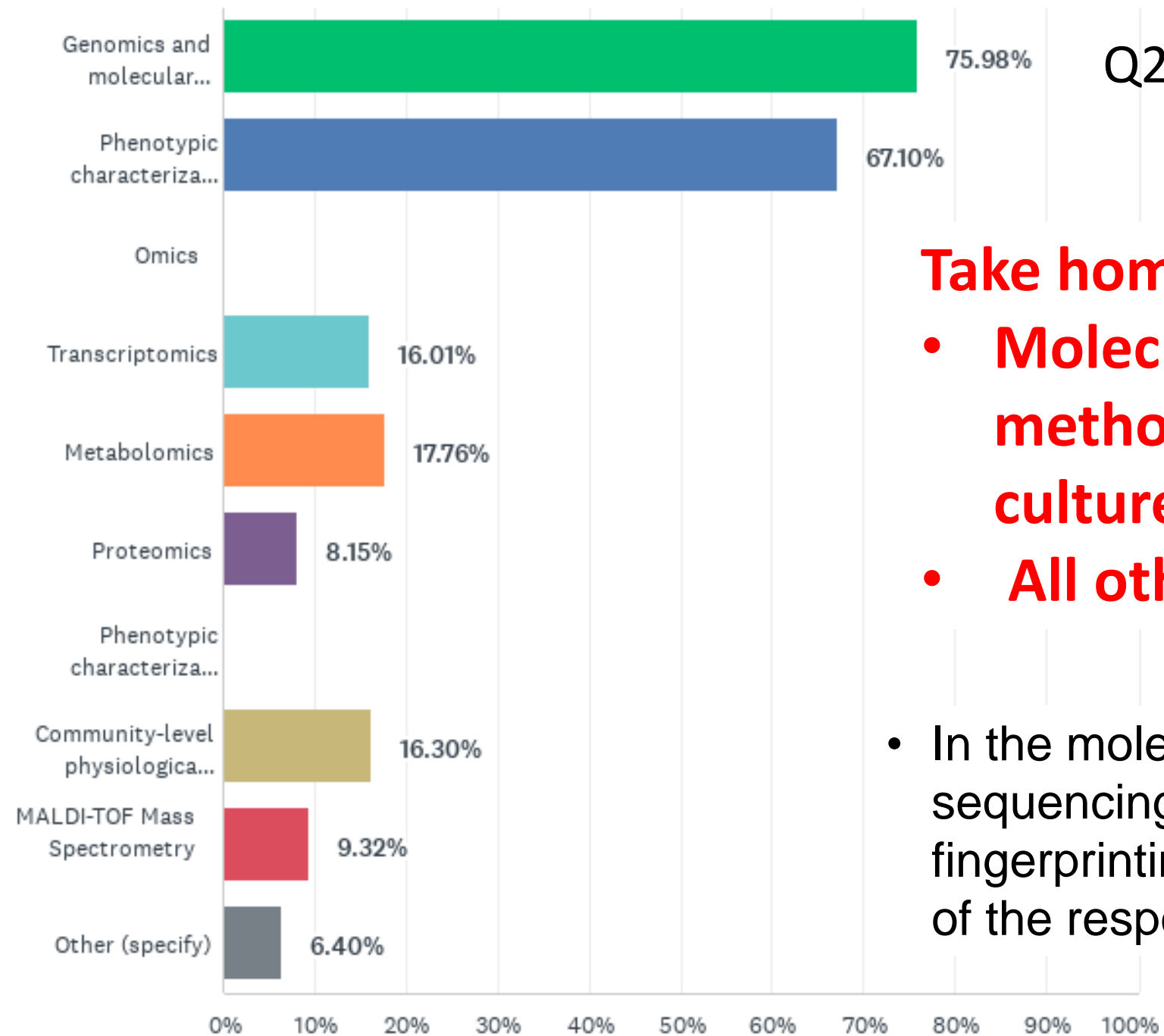
Q17: What microbes do you work with?



Take home:

- **Bacteria & fungi most studied (79-85%)**
- **Other taxa less (7-25%)**
- Not surprising => importance in soils
- Historically, most studied
- Taxa with well established molecular markers (ribosomal genes and ITS region).

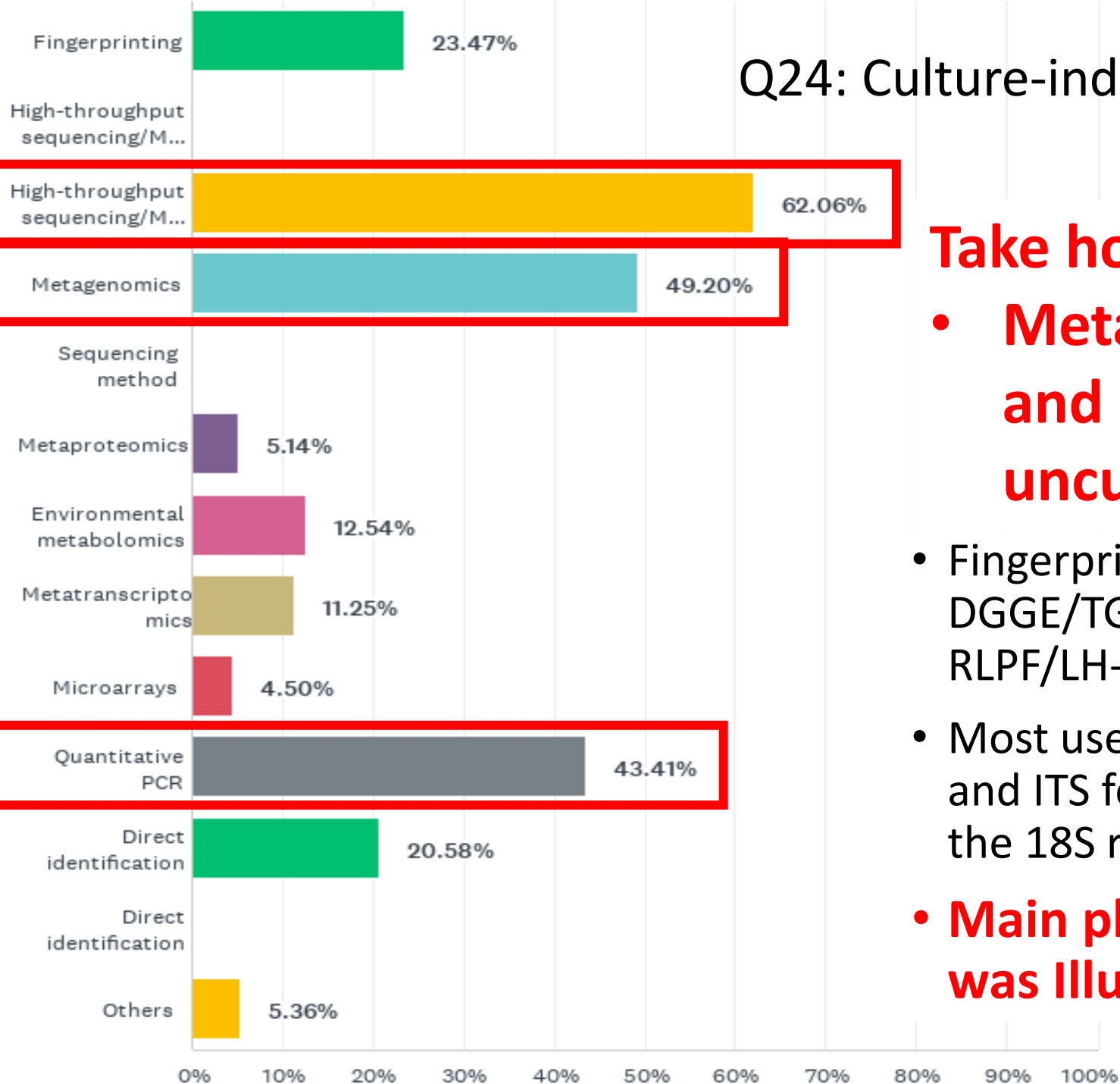
Q24: Culture-dependent methods



Take home:

- **Molecular and phenotypic methods most used for cultured microbes (67-76%)**
- **All other methods <18%**
- In the molecular methods, genome sequencing, marker gene sequencing, and fingerprinting used by 64%, 59%, and 45% of the respondents

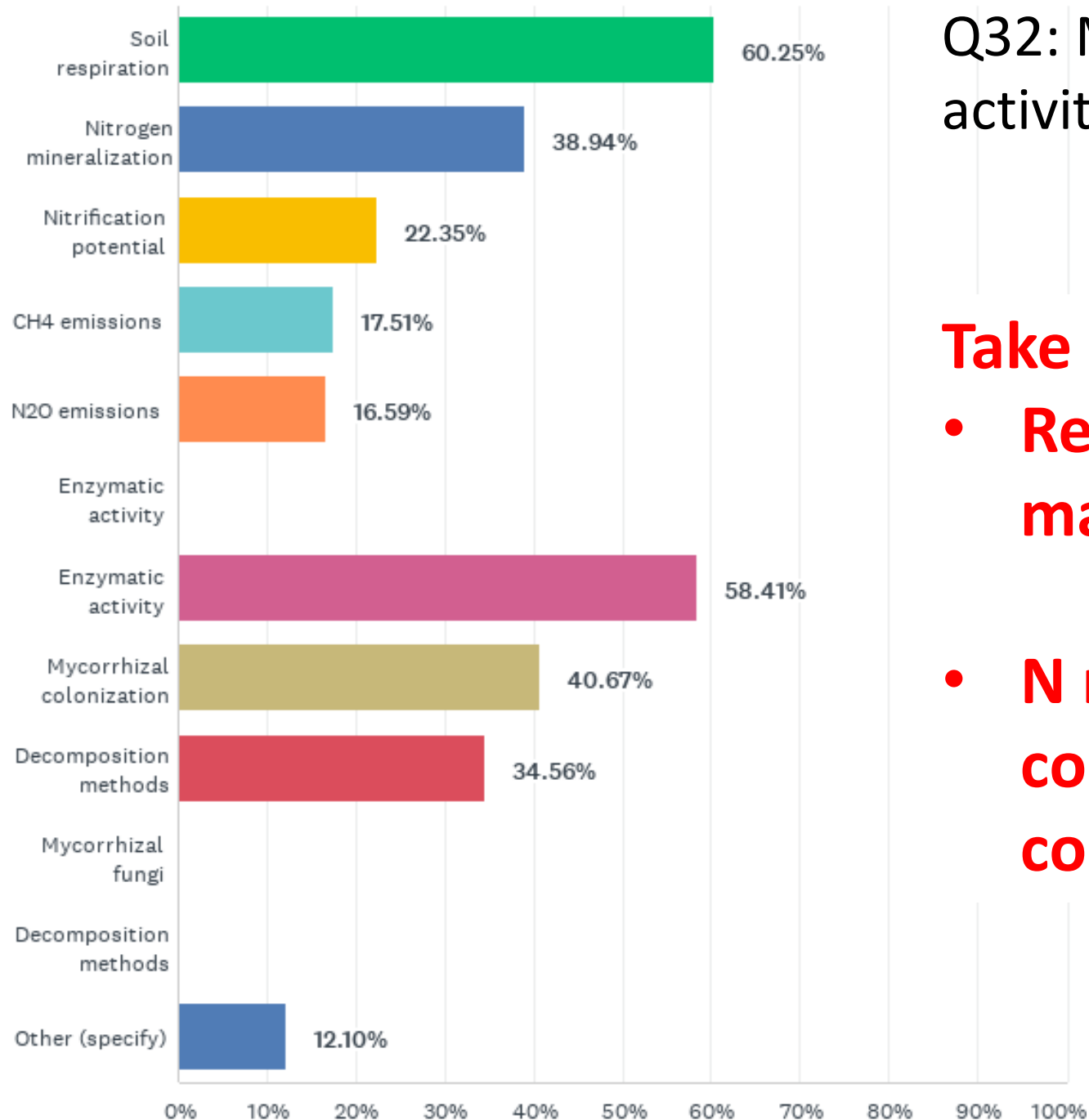
Q24: Culture-independent/molecular methods



Take home:

- **Metabarcoding, metagenomics, and qPCR, most used for uncultured microbes (43-62%)**
- Fingerprinting = 23% of respondents (n = 634): DGGE/TGGE (33%), PLFA/FAME (27%), T-RLPF/LH-PCR (25%) and RLFP (23%);
- Most used 16S rRNA gene for prokaryotes (88%) and ITS for fungi (68%), with a smaller focus on the 18S rRNA gene for fungi (42%);
- **Main platform used for metabarcoding was Illumina (92%).**

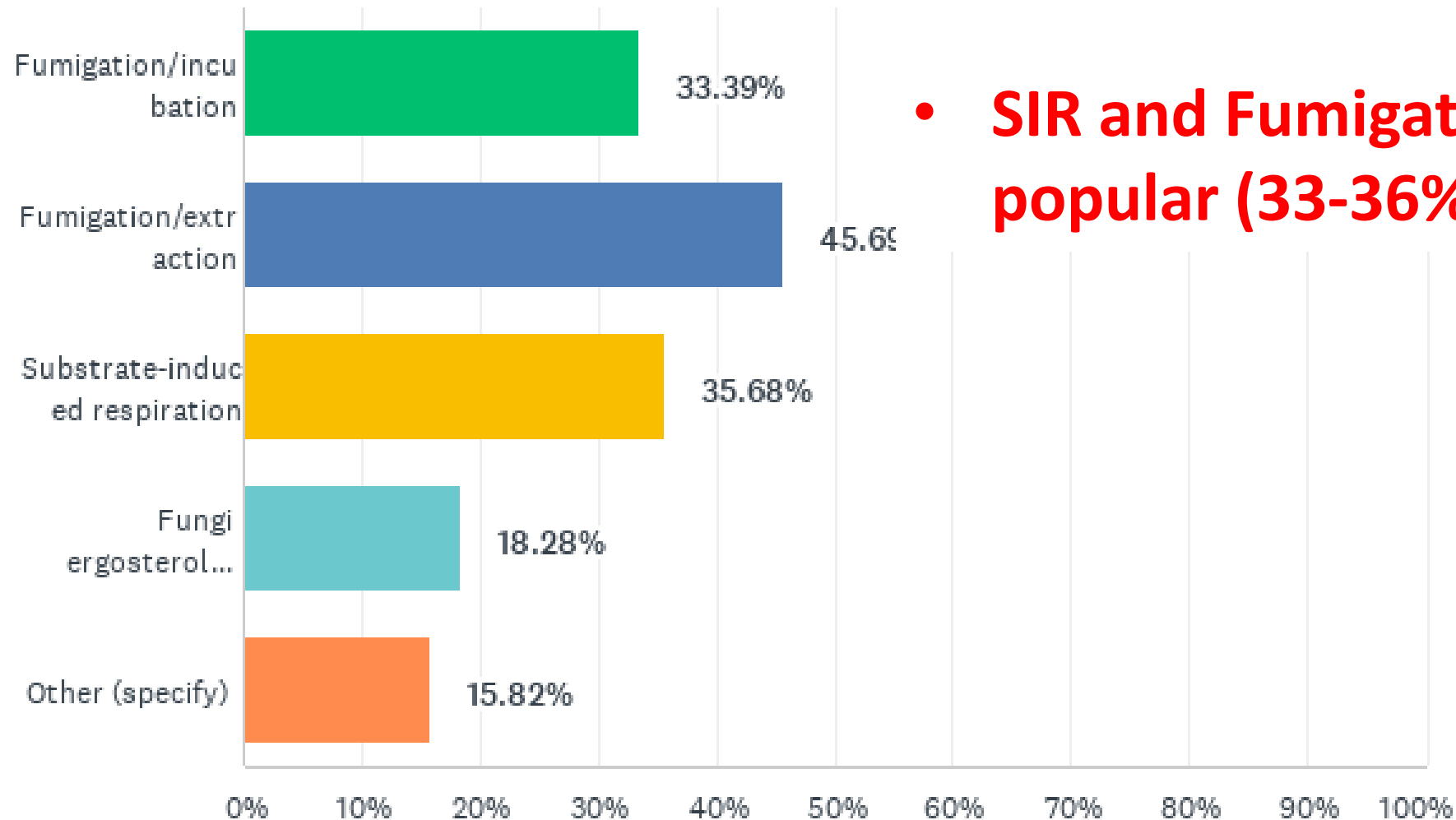
Q32: Methods to evaluate microbial activity/processes



Take home:

- **Respiration and enzymatic activity main processes evaluated (~60%)**
- **N mineralization, mycorrhizal colonization & decomposition less common (35-41%)**

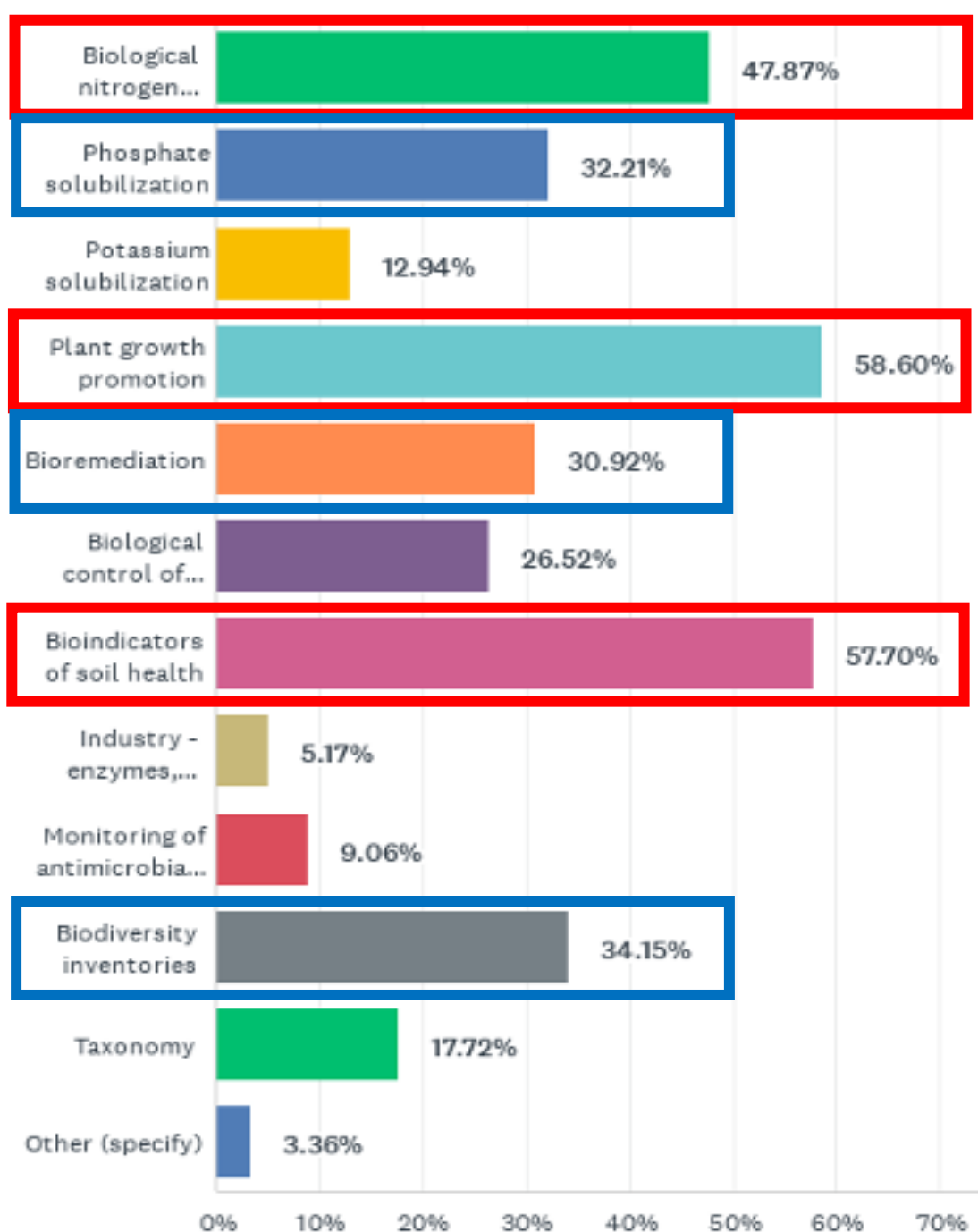
Q40: Microbial biomass methods



Take home:

- **Fumigation/extraction main method used (~46%)**
- **SIR and Fumigation/incubation less popular (33-36%)**

Q107: Main practical applications of microbes

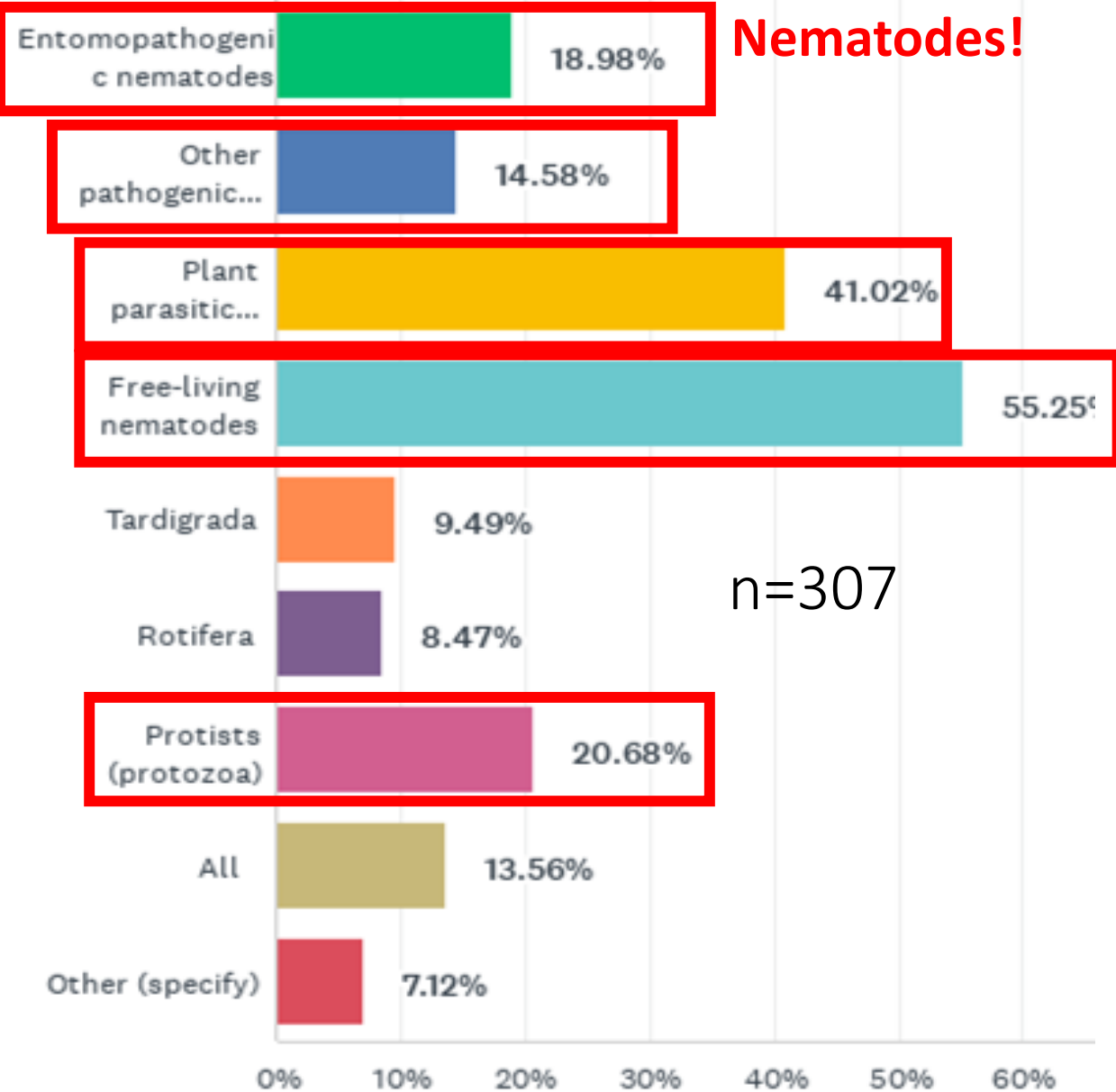


Take home:

Main uses of microbes are:

- Plant growth promotion
- Bioindicators
- BNF
- Inventories
- P-solubilization
- Bioremediation
- Biological control

Q48: Microfauna studied



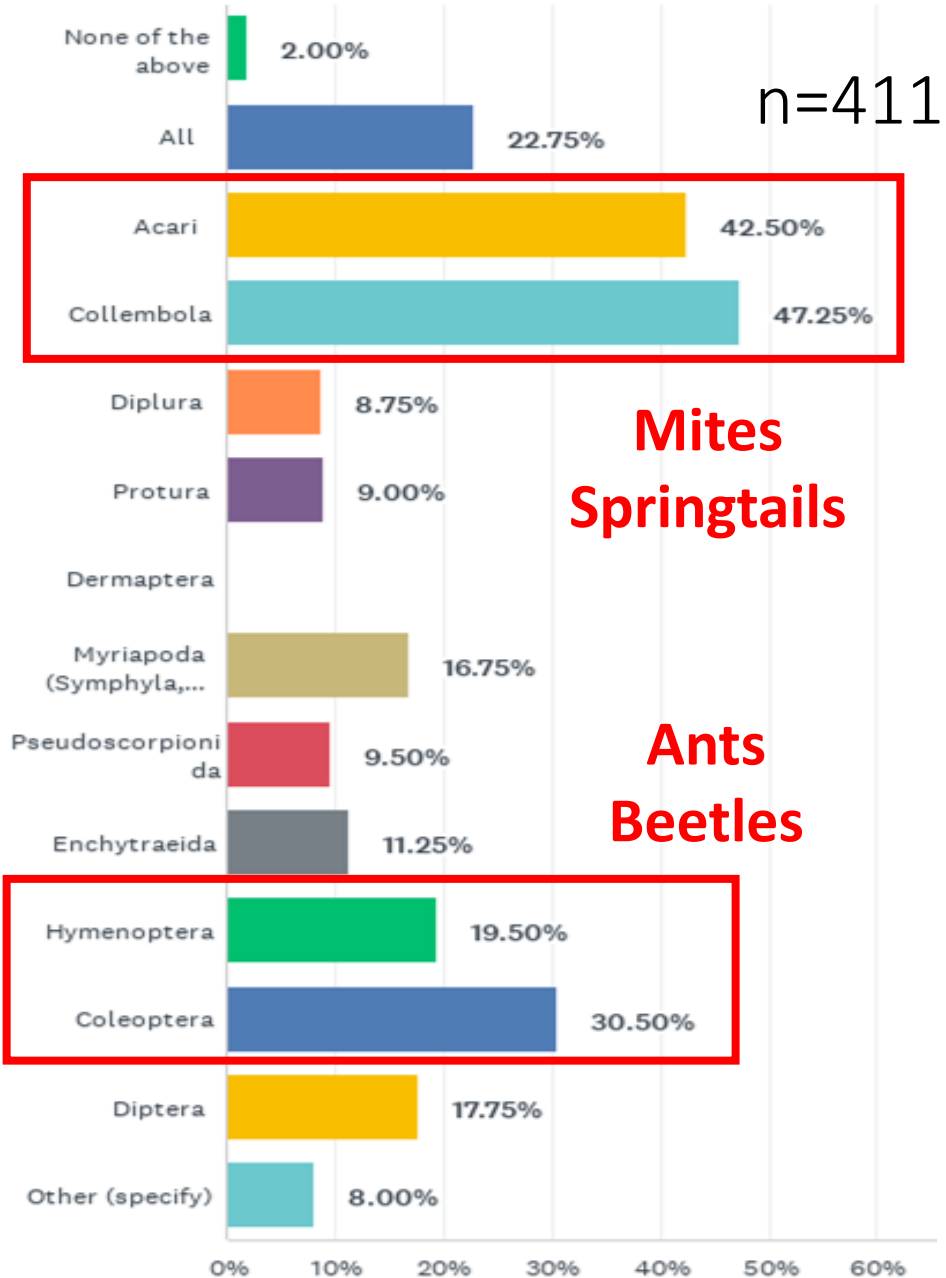
Take home:

- **Nematodes most studied**
 - **Freeliving = 55%**
 - **Plant parasitic = 41%**
- **Protozoa (21%)**
- **Tardigrades & rotifers <10%**

- **Most nematodes extracted by wet funnels (57% Baermann)**
- **Protozoa various methods**

- **Few active taxonomists (26%)**

Q61: Mesofauna studied

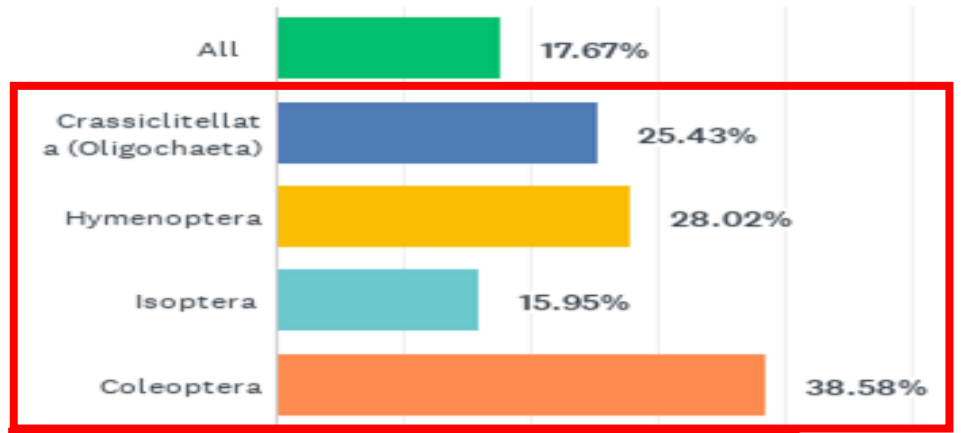


Take home:

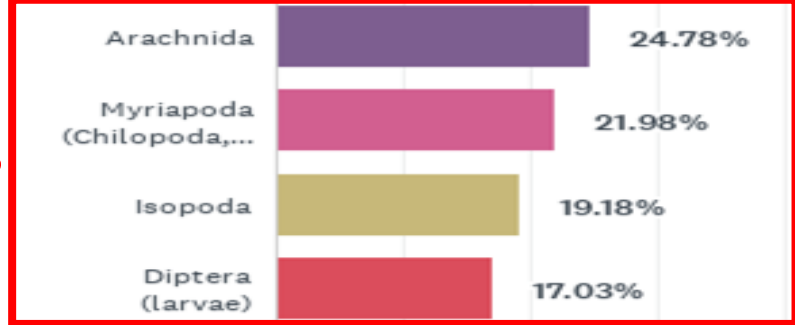
- **Mites & springtails most studied (43-47%)**
- **Beetles = 30%, ants = 20%**
- **Others all <18%**
- **23% study whole community**
- **Most extracted with Berlese or Tullgren funnels (55%)**
- **30% used Pitfall traps**
- **Only 33% active in taxonomy**

Q74: Macrofauna studied

Mainly
Ecosystem
engineers



Predators,
Detritivores



Plant
feeders

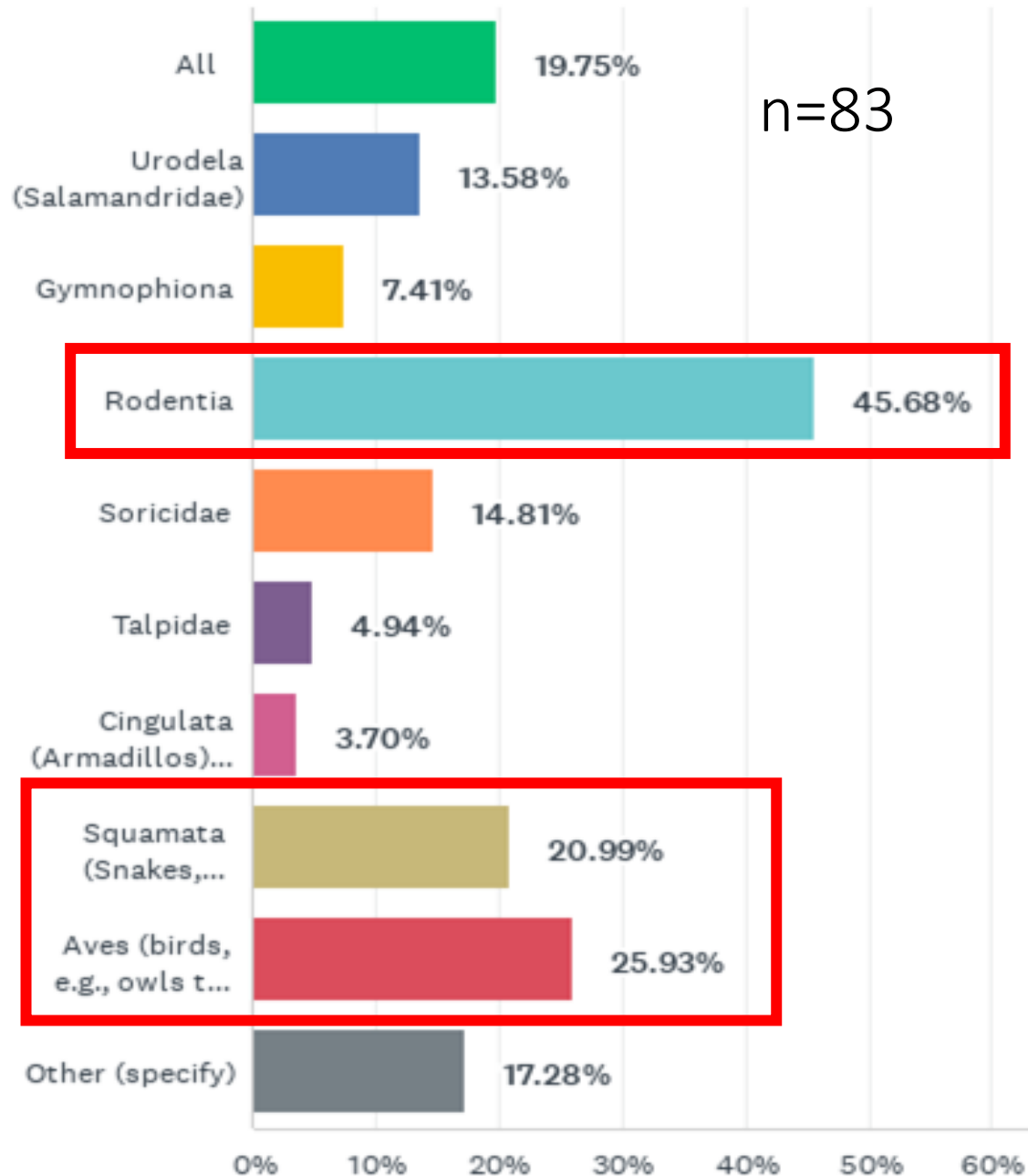


n=477

Take home:

- Mostly ecosystem engineers (16-39%) and predators & detritivores studied (17-25%)
- Phytophages <12%
- 18% study whole community
- Most extracted directly by handsorting (94%) or indirectly by pitfall traps (79%)
- Only 31% active in taxonomy

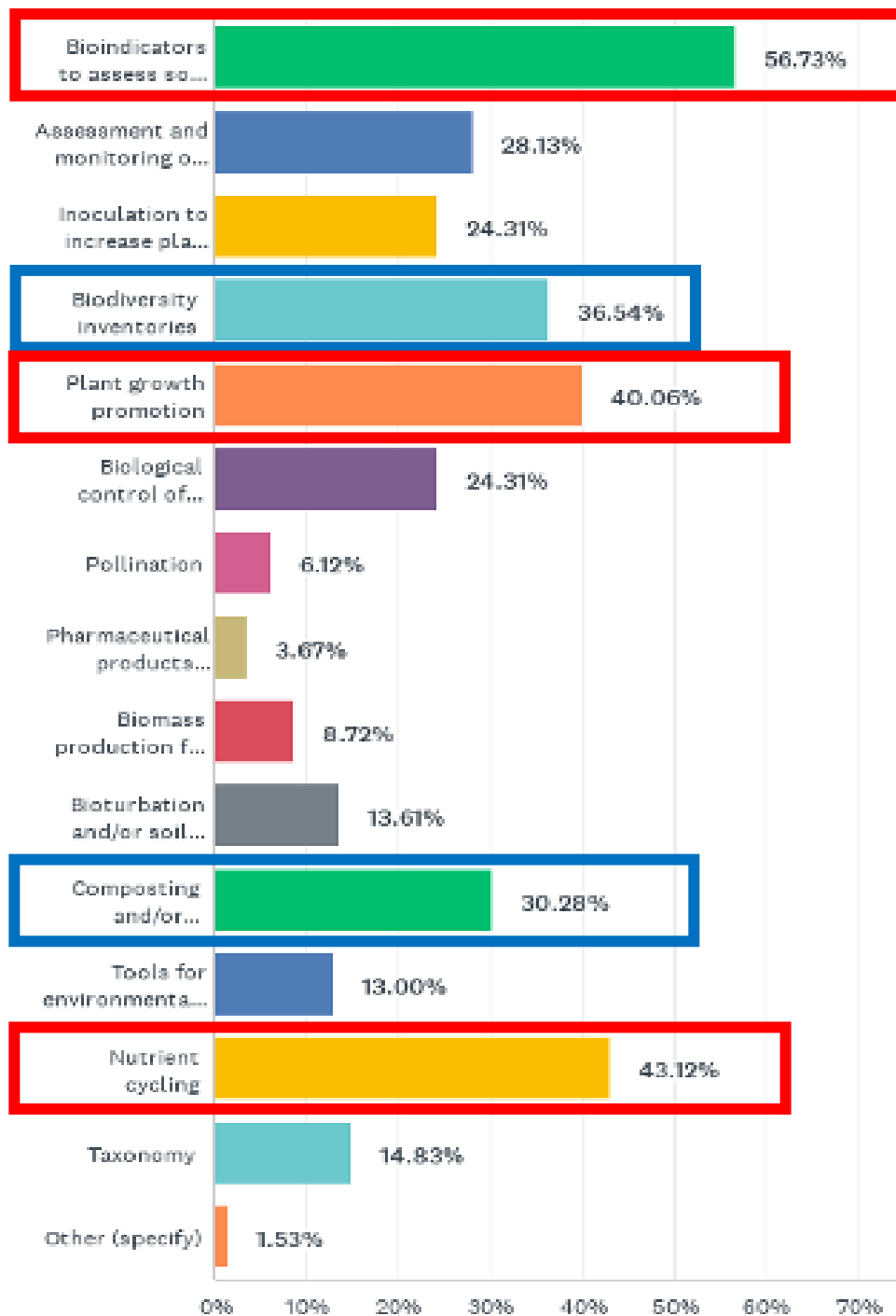
Q81: Megafauna studied



Take home:

- Rodents most studied (46%)
- Birds and snakes less popular (21-26%)
- Methods taxon-dependent
- Few respondents overall
- Only 19% active in taxonomy

Q108: Main applications of soil fauna studies

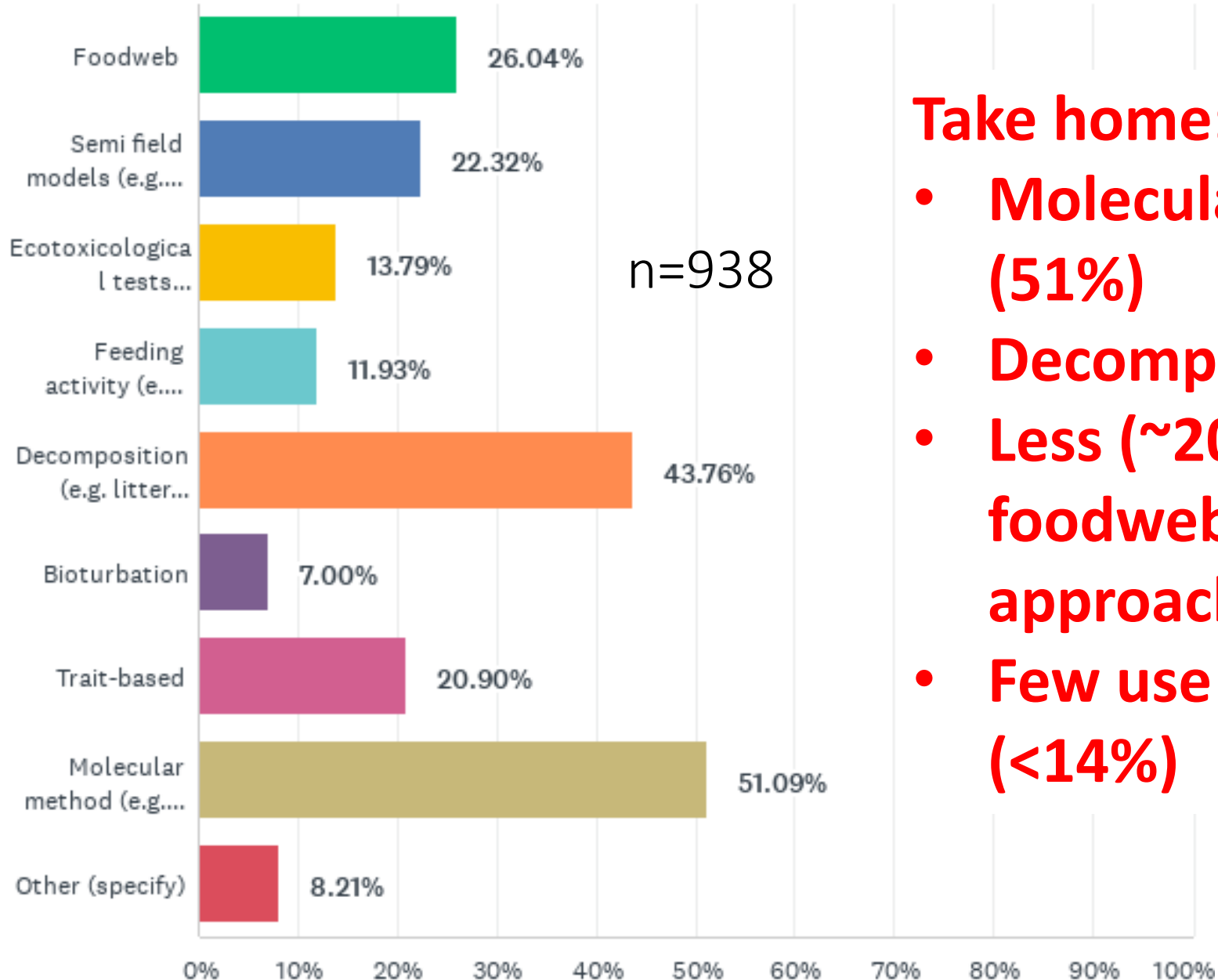


Take home

Main uses of soil fauna:

- Bioindicators
- Nutrient cycling
- Plant growth promotion
- Inventories
- Composting
- Monitoring
- Inoculation
- Biological control

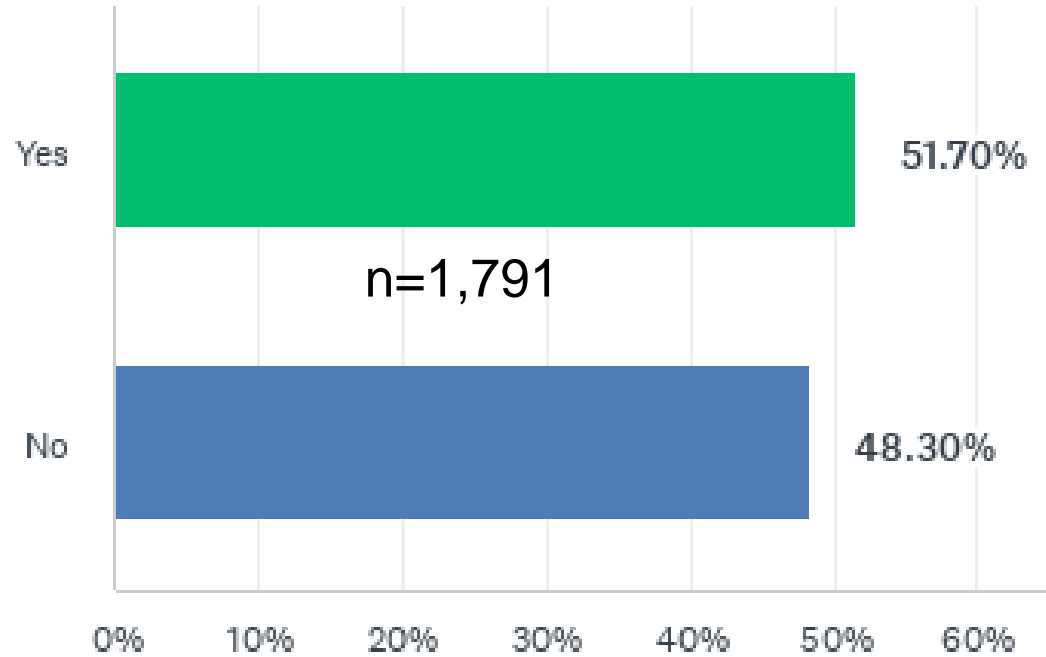
Q86: Methods to evaluate fauna/microbial functions



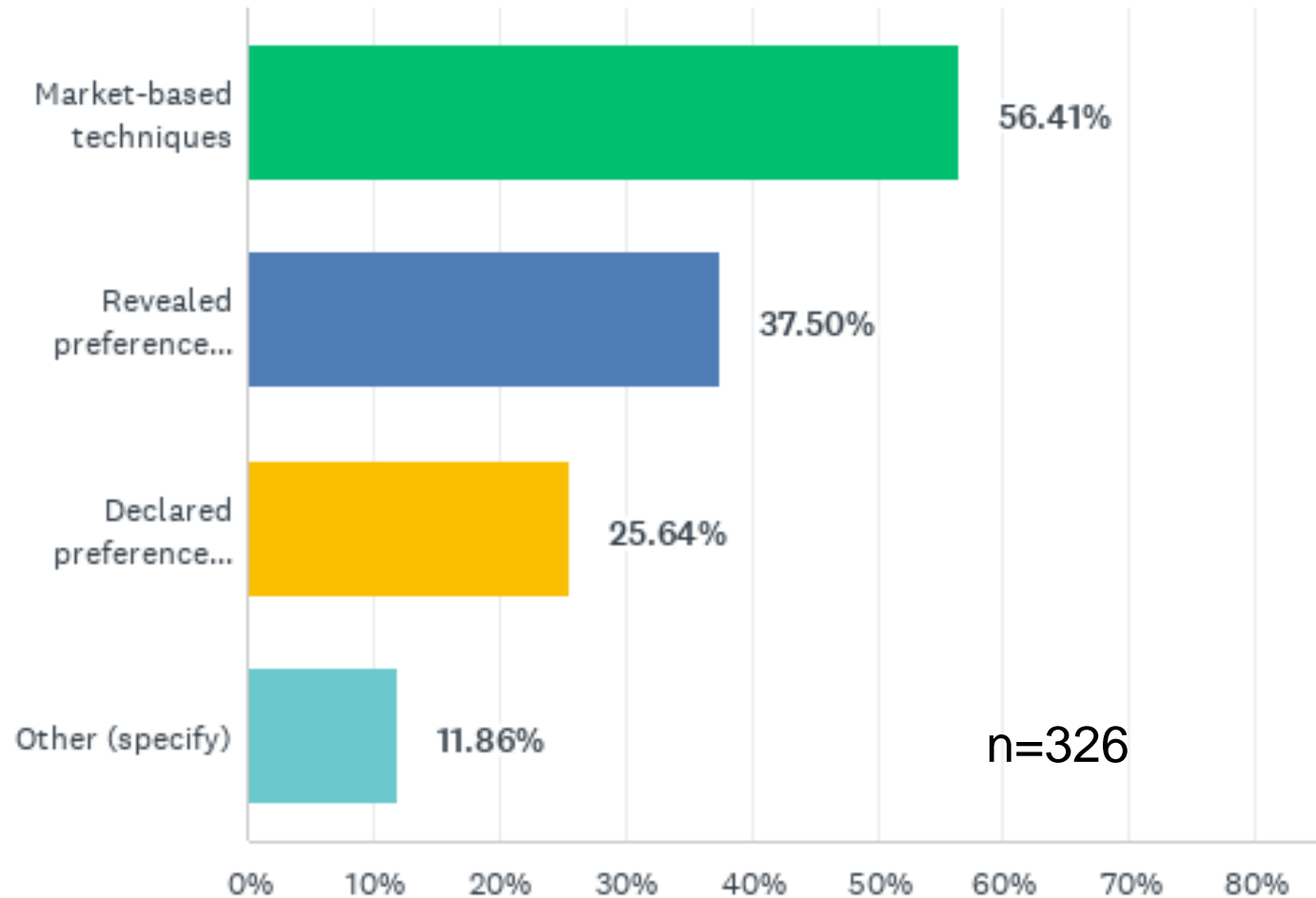
Take home:

- **Molecular methods most popular (51%)**
- **Decomposition widely used (44%)**
- **Less (~20-26%) use semi-field, foodweb or trait-based approaches**
- **Few use ecotox or bioturbation (<14%)**

Q100: Do you work with Ecosystem Services?



Q104: Approaches used for economic valuation



Take home:

- **Around 51% study ES**
- **Most use market-based valuation (56%)**
- **Less (26-38%) use other techniques**

ANSWER CHOICES	RESPONSES	
Soil formation (1)	26.59%	246
Biodiversity conservation (2)	51.68%	478
Nutrient cycling (Decomposition, N2 fixation, Mineralization, etc.) (3)	69.19%	640
Soil erosion and flood control (4)	26.70%	247
Pollination (5)	10.38%	96
Seed dispersal (6)	7.78%	72
Pest and disease regulation (7)	21.08%	195
Atmospheric composition and climate regulation (Emission of GHG, Carbon sequestration, etc.) (8)	26.92%	249
Recycling of waste biomass (9)	22.92%	212
Pollutant immobilization/degradation and soil bioremediation (10)	20.76%	192
Regulation of water supply and quality (11)	14.59%	135
Pharmaceutical or biotechnological products (12)	4.86%	45
Food, fibre and fuel production and quality (13)	16.43%	152
Human health (14)	8.86%	82
Educational, cultural or recreational uses (15)	13.95%	129
Habitat for organisms (16)	22.59%	209
Others (please list) (17)	3.68%	34

Q101: Ecosystem services of soil biodiversity

Take home:

Most services studied:

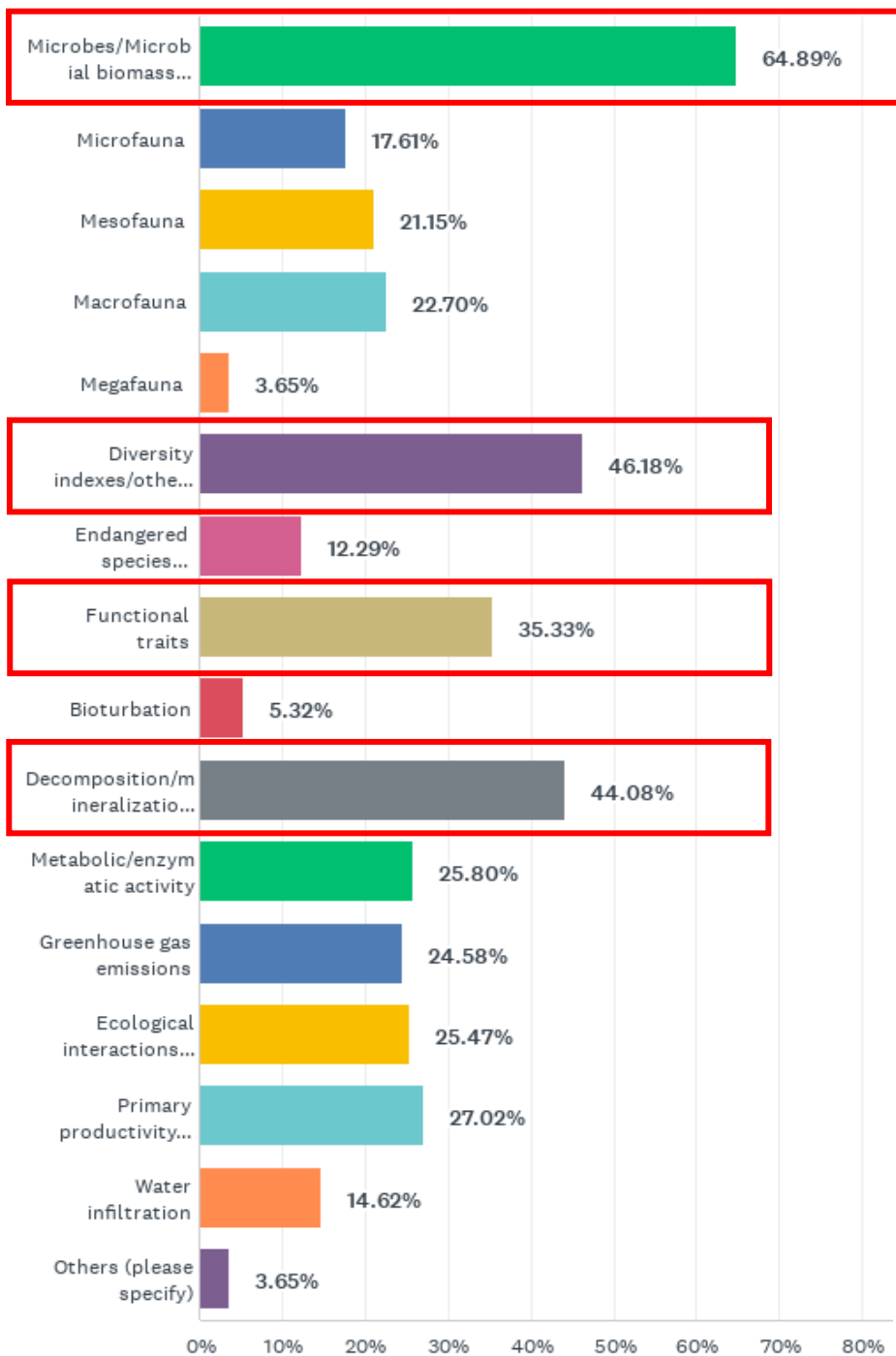
- Nutrient cycling
- Biodiversity conservation
- Climate regulation
- Erosion/flood control
- Pedogenesis
- Waste recycling
- Habitat

Q102: Main indicators used to evaluate ES

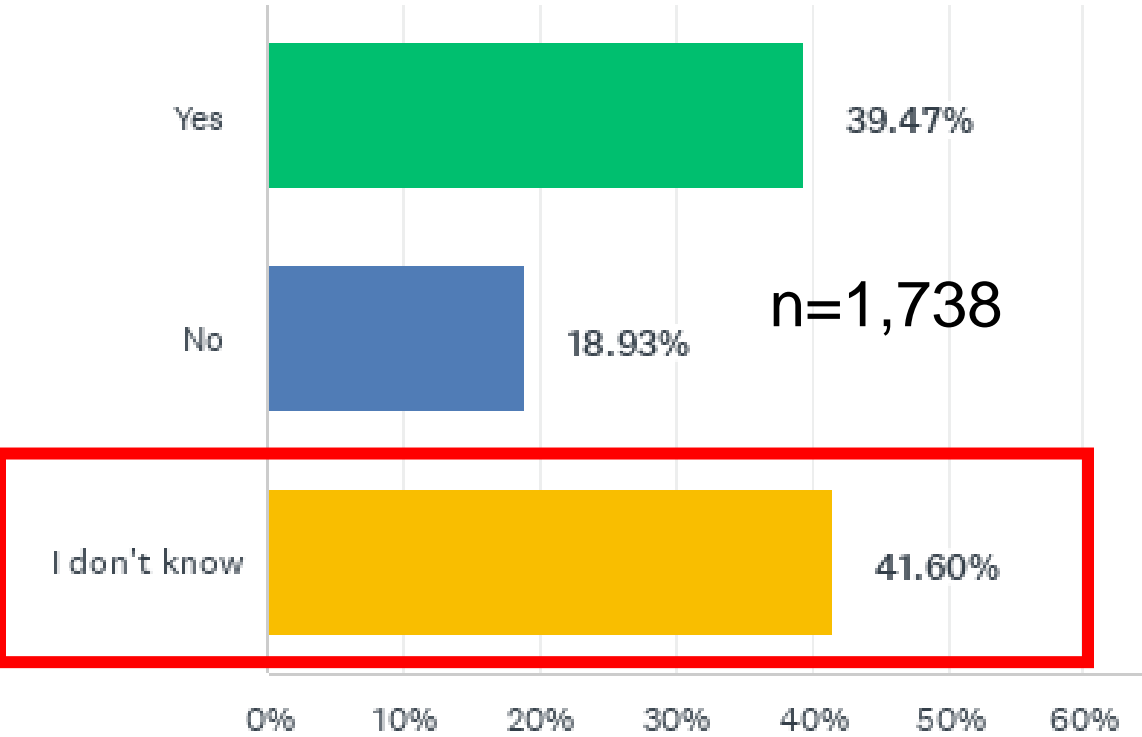
Take home:

Most common indicators:

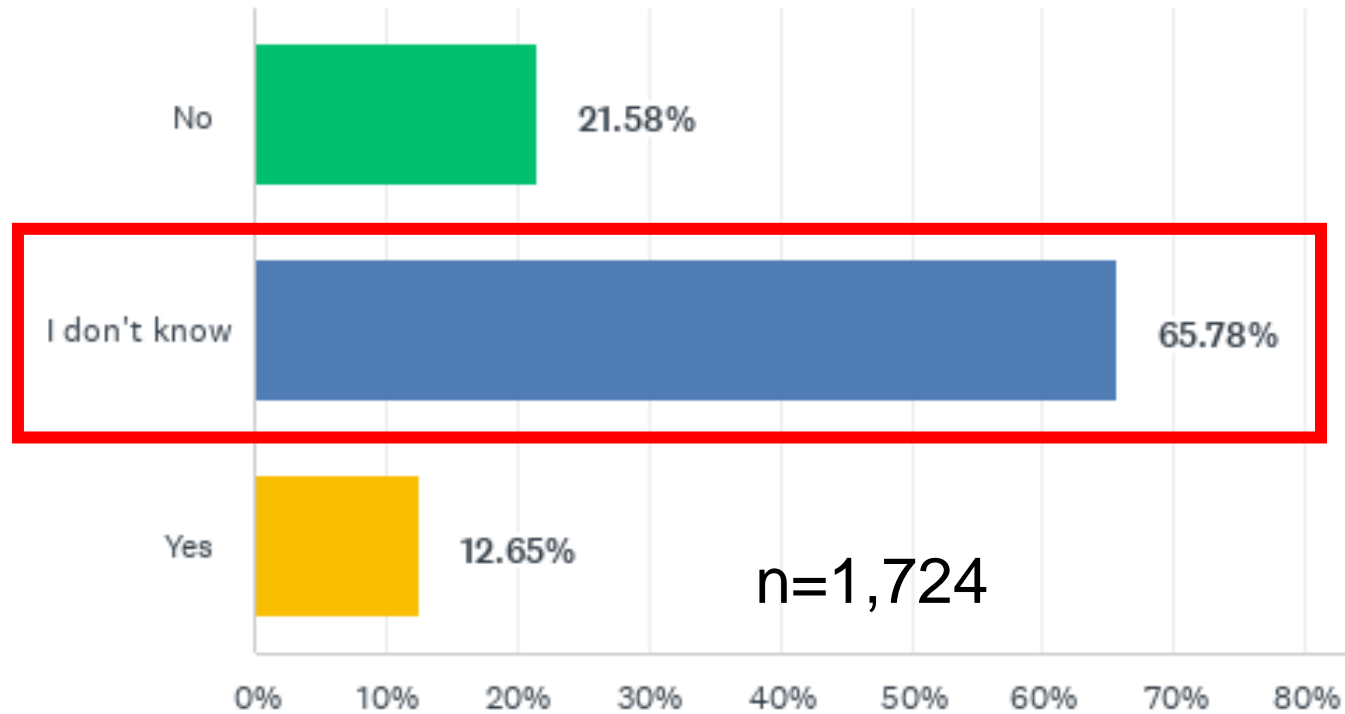
- Microbes/biomass (65%)
- Diversity indices (46%)
- Decomposition/mineralization (44%)
- Functional traits (35%)
- Primary production (27%)
- Enzymes, GHG, ecological interactions (25-27%)
- Fauna less used (4-23%)



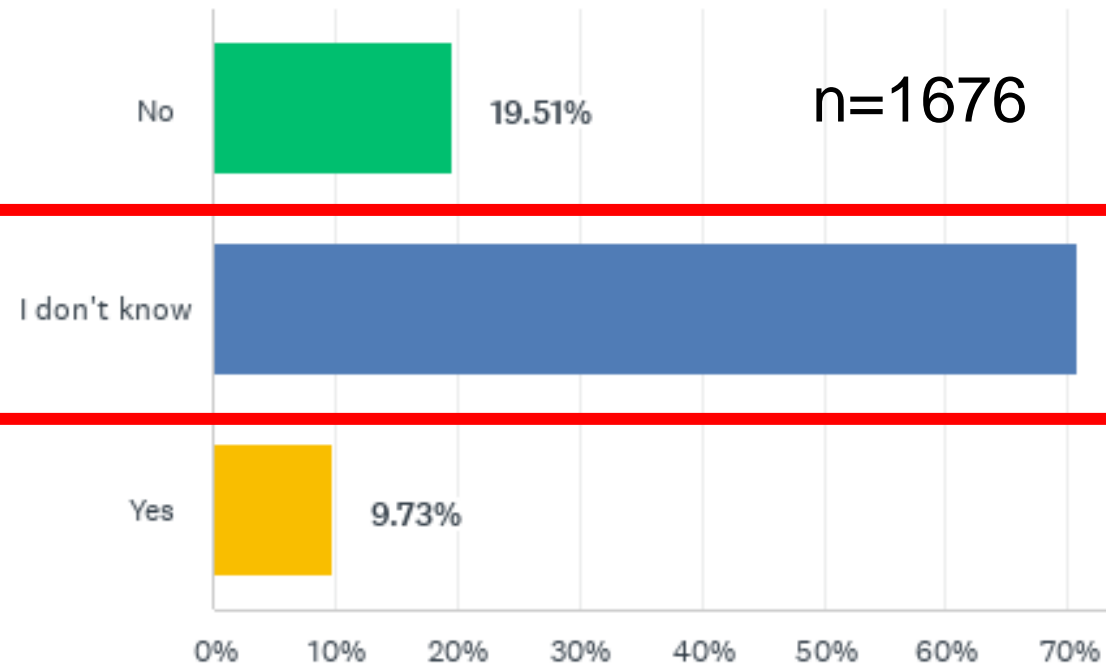
Q117: Legal frameworks promoting conservation/sustainable management



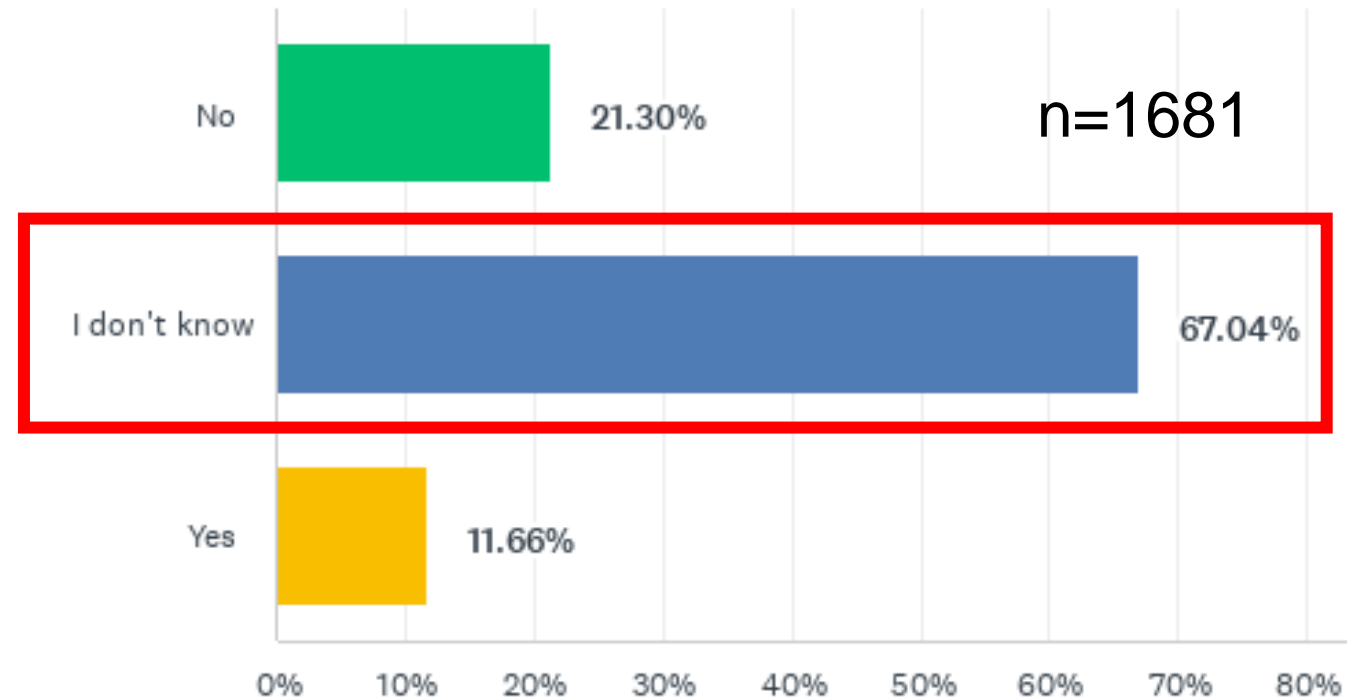
Q118: Public policy on soil biodiversity



Q122: International legal instrument to
protect soils relevant to soil biodiversity



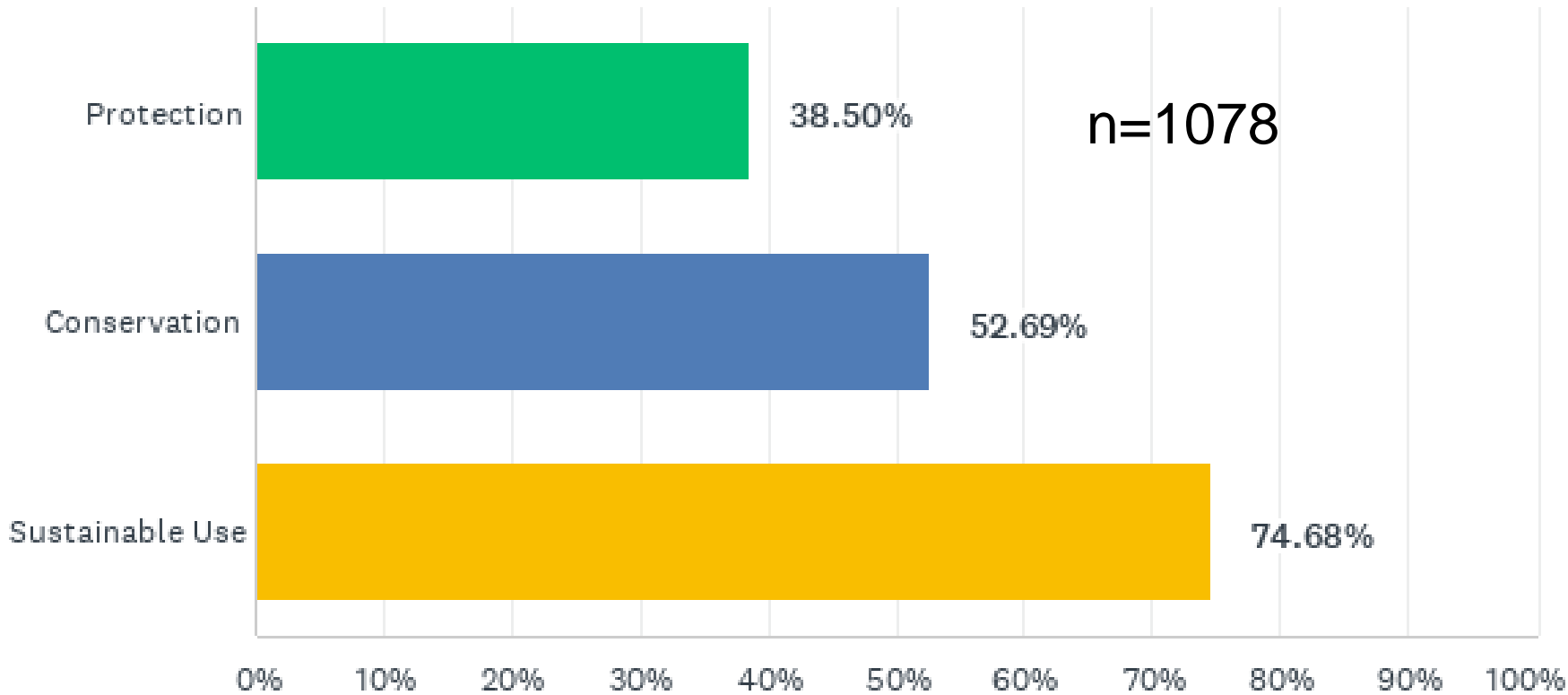
Q121: National measures to
protect soil biodiversity



Take home:

- **Little knowledge of legal instruments or public policies!**

Q121: Main focus of soil biodiversity public policy



Take home:

- Most policies target sustainable use (75%) and conservation (53%)
- Less protection of soil & its biodiversity (39%)



Conclusions

- Soil BD is mostly government-based or educational research
- Main focus on managed systems & microbes vs. fauna
- Few active taxonomists for all taxa
- Max 50 countries have inventories/monitoring programs & most focus on microbes vs. fauna
 - Few target wide range of taxa
- ES studies are popular and use wide range of indicators
- Little knowledge on public policies & frameworks related to soil biodiversity



Thank you for your attention!

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