**Multi-Pathway, Multi-Pesticide Exposure in Ethiopia: Systematic Review Protocol**

*Asefa et al. 2024*

# Research Objectives

We aim to map available evidence on multi-pathway exposure to pesticides among the general population in Ethiopia by compiling data on pesticide occurrence across multimedia sources (e.g., air, water, soil, food, and other environmental matrices). Using systematic review and evidence mapping methods, we will collect and synthesize published pesticide monitoring studies that focus on indirect environmental exposure (i.e., through residue measurements in surrogate media). The outcomes will include a summary of pesticide exposure research and knowledge gaps in Ethiopia, as well as the generation of a curated, comprehensive database on pesticide mixture exposures for further cumulative health impact analyses.

To achieve these objectives, we will follow the Office of Health Assessment and Translation framework (OHAT, 2019) as our primary guide, supplemented by the Navigation Guide framework where appropriate (Woodruff and Sutton, 2014). The Reporting Standards for Systematic Evidence Syntheses (ROSES) framework will be used for reporting (Haddaway *et al.*, 2018).

# Problem Formulation

Given the diverse sources of pesticides and their varying properties, accurately characterizing human exposure remains challenging. However, understanding pesticide levels in multiple media and identifying potential exposure pathways is essential for establishing clear links between exposure and adverse health outcomes (El Afandi and Irfan, 2024; Ahmad *et al.*, 2024; U.S.EPA, 2022). Comprehensive exposure assessments should consider all possible sources and pathways, along with major predictors, but such approaches are rarely employed in the existing literature.

Unlike occupational pesticide exposure, where the magnitude, frequency, and duration can be more easily quantified and controlled, assessing exposure in the general population is more complex (Gangemi *et al.*, 2016; U.S.EPA, 2023). General population exposures are influenced by numerous factors, leading to greater uncertainty. For instance, pesticides in environmental media (e.g., air, soil, water) can enter the human body through multiple pathways, governed by personal habits, environmental conditions, and other variables (Kalyabina *et al.*, 2021; Tudi *et al.*, 2022). Although non-occupational exposure pathways are often considered negligible, they may be more significant than previously thought, as the general population faces constant exposure through various indirect routes (Holder *et al.*, 2023). However, studies addressing these pathways are limited in scope, typically focusing on specific pesticides (e.g., neonicotinoids), populations (e.g., farming families), sample types (e.g., house dust), or developed nations.

Given these gaps, it is essential to explore and synthesize how pesticide exposure among the general population has been studied to date. Information on primary sources, routes of exposure, temporal variability, and relevant predictors will help improve study designs, sampling strategies, and interpretations of health implications. Such insights will also guide recommendations to limit exposure where necessary. Unfortunately, there is significant geographical bias in the pesticide research landscape, with the majority of evidence extrapolated from the Global North. Pesticide research in the Global South, including Ethiopia, remains fragmented and sparse, despite the fact that this part of the globe hosts the most exposed and vulnerable populations (approximately 85% of the world’s population lives here).

## Literature Search Strategy

To ensure a thorough and unbiased identification of relevant studies, a systematic literature search will be conducted across a range of global and local databases. This search aims to capture research on pesticide occurrence in various environmental media, ultimately contributing to the creation of a comprehensive database on multi-pathway, multi-pesticide exposure specifically in Ethiopia. By including both international databases and local repositories, we seek to address potential geographical biases and incorporate evidence that may not be indexed in mainstream global sources. The selected databases encompass a mix of multidisciplinary platforms (e.g., Web of Science, Scopus, PubMed) for broad coverage of peer-reviewed literature, open-access tools (e.g., OpenAlex, Google Scholar, Semantic Scholar, OAIster) to capture grey literature and emerging research, and local Ethiopian university repositories (e.g., Addis Ababa University, Haramaya University) to include region-specific theses, reports, and datasets. A detailed list of these databases, along with the tailored search strategies applied to each and the results from the piloted searches, is provided in Table 1.

The search strategy was developed iteratively to maximize sensitivity and relevance (Lagisz *et al.*, 2025). First, we drafted a core set of search terms related to key concepts: pesticides (e.g., pesticide, agrochemical, insecticide, fungicide, herbicide), occurrence or exposure (e.g., pollution, exposure, monitoring, residue, contamination, air, soil, water, food), and the geographic focus (Ethiopia). To validate the sensitivity of these terms and ensure they would retrieve a comprehensive set of relevant studies, we tested them using a Scopus search against a predefined set of 25 benchmark articles that were identified a priori as highly relevant to the topic. These benchmark articles represent a gold standard for evaluating search performance, and a complete list of them, along with the specific search strategy used for this sensitivity analysis, is provided in Appendix 1. The validation process confirmed the robustness of our approach, as the search strategy successfully retrieved 100% of the benchmark articles, thereby demonstrating its high sensitivity and comprehensiveness in capturing pertinent literature without missing key evidence. Following validation, we adapted the search terms to suit the unique features of each database, taking into account variations in indexing systems, controlled vocabularies (e.g., MeSH terms in PubMed), and search functionalities. With the refined strategies in place, we conducted a pilot search across all databases to assess feasibility and estimate the volume of records. This pilot yielded varying hit counts per database, as detailed in Table 1, providing an initial indication of the evidence landscape.

To further enhance completeness and mitigate any potential gaps in database coverage, we will supplement the electronic searches with manual methods. Specifically, we will hand-search the reference lists of included studies and relevant review articles identified during screening. This backward citation searching will help uncover additional publications that may not have been captured by the database queries, ensuring a more exhaustive collection of evidence on pesticide exposure in Ethiopia.

*Table 1: Lists of database and repositories, search strategies used, and pilot search results.*

|  |  |  |
| --- | --- | --- |
| **Database** | **Search strategy** | **Hits** |
| Web of Science | ((TS=(pesticide OR agrochemical OR insecticide OR fungicide OR herbicide)) AND TS=(pollution OR exposure OR monitoring OR residue OR contamination OR air OR soil OR water OR food)) AND TS=(Ethiopia) | 426 |
| Scopus | ( TITLE-ABS-KEY ( pesticide OR agrochemical OR insecticide OR fungicide OR herbicide OR organochlorine OR ocp OR ddt ) AND TITLE-ABS-KEY ( pollution OR exposure OR monitoring OR concentration OR level OR residue OR contamination OR air OR soil OR water OR food ) AND TITLE-ABS-KEY ( ethiopia ) AND NOT TITLE-ABS-KEY ( mosquito\*) ) | 478 |
| PubMed | (((pesticide[MeSH Terms] OR agrochemical[MeSH Terms] OR insecticide[Title/Abstract] OR fungicide[Title/Abstract] OR herbicide[Title/Abstract] OR organochlorine[Title/Abstract] OR ocp[Title/Abstract] OR ddt[Title/Abstract]) AND (pollution[Title/Abstract] OR exposure[Title/Abstract] OR monitoring[Title/Abstract] OR concentration[Title/Abstract] OR level[Title/Abstract] OR residue[Title/Abstract] OR contamination[Title/Abstract] OR air[Title/Abstract] OR soil[Title/Abstract] OR water[Title/Abstract] OR food[Title/Abstract])) AND (Ethiopia[Title/Abstract])) NOT (mosquito[MeSH Terms]) AND (2000:2025[pdat]) | 231 |
| OpenAlex | (pesticide OR agrochemical OR insecticide OR fungicide OR herbicide) (pollution OR exposure OR monitoring OR concentration OR level OR residue OR contamination OR air OR soil OR water OR food) Ethiopia | 990 |
| Google Scholar | allintitle: (pesticide OR agrochemical OR insecticide OR fungicide OR herbicide) (pollution OR exposure OR monitoring OR residue OR contamination OR air OR soil OR water OR food) Ethiopia | 63 |
| Semantic scholar | (pesticide) (air, water, soil, food pollution OR contamination) "Ethiopia" | 90 |
| OAIster | (pesticide OR agrochemical OR insecticide OR fungicide OR herbicide) AND (pollution OR exposure OR monitoring OR concentration OR level OR residue OR contamination OR air OR soil OR water OR food) AND Ethiopia | 116 |
| Local repositories | Addis Ababa University, Haramaya University, Jimma University, Bahir Dar University, Hawassa University, The University of Gondor (Pesticide) |  |

## Eligibility Criteria

***Geographic Scope:*** Studies must be conducted in Ethiopia (any region, urban or rural setting, or ecosystem within the country). This includes studies with data from Ethiopian sites, even if part of multi-country analyses (e.g., regional African studies), provided Ethiopia-specific data can be extracted.

***Population Focus:*** Studies must focus on the general population in Ethiopia (e.g., non-occupational groups such as residents, consumers, or communities exposed via environmental routes). This includes subpopulations such as farming families, rural dwellers, or vulnerable groups (e.g., children, pregnant women) if exposure is indirect or non-occupational. Studies focusing exclusively on occupational populations (e.g., pesticide sprayers) or non-human populations (e.g., animal or insect studies, in vitro experiments); or on specific non-general populations without broader applicability (e.g., only hospital patients or factory workers unrelated to environmental exposure) will be excluded.

***Exposure Focus:*** Studies must report on at least one pesticide in any environmental surrogate media. Media types include air, water (e.g., surface water, groundwater, drinking water), soil or sediment, food (e.g., crops, produce, dietary items), house dust, or other matrices indicating indirect (non-occupational) exposure pathways. Pesticide types include, but are not limited to, insecticides, fungicides, herbicides, or mixtures. Studies extrapolating environmental media data to human exposure estimates (e.g., via modeling) are also eligible. Studies focusing solely on occupational exposure (e.g., direct handling or application by farmers or workers) without environmental media measurements; studies on pesticide efficacy, application methods, or agricultural trials without residue or occurrence data in media; and direct human biomonitoring (e.g., blood or urine levels) without linkage to environmental media or pathways will be excluded.

***Outcome Data:*** Studies must provide extractable data on pesticide residues or levels (e.g., quantitative measurements such as mg/kg or μg/L, or qualitative descriptions of detection frequency). Data should support evidence mapping, gap identification, and database curation (e.g., details on sources, routes, temporal variability, or predictors such as environmental conditions or personal habits). Studies with no extractable data on pesticide residues or levels in media (e.g., policy papers, opinion pieces, or studies reporting only health outcomes without exposure measurements); or those focused on health effects (e.g., toxicity, epidemiology) without underlying exposure data from media will be excluded.

***Study Design and Type:*** Primary research, including peer-reviewed pesticide monitoring, modeling, or observational studies (e.g., environmental sampling, residue analysis, exposure assessments) is eligible. This includes cross-sectional, longitudinal, or cohort studies reporting media measurements. Grey literature, such as theses, reports, or published datasets, is eligible if residue measurement details are provided. Non-empirical studies (e.g., editorials, commentaries, protocols without data); modeling studies without empirical media measurements; and studies on mosquito control or vector-borne disease interventions (e.g., bed nets, insecticides for malaria), unless they report environmental residues relevant to general population exposure, will be excluded.

***Publication Date:*** Studies published from January 1, 2000, to the date of the final search are eligible. Earlier studies may be considered if deemed highly relevant, but the focus is on contemporary evidence to reflect current exposure patterns.

***Language:*** English-language publications, as well as those in local languages that the authors can understand and translate (e.g., Amharic).

***Other:*** Studies must be accessible in full text for data extraction.

## Study Selection and Screening

All records from databases and repositories will be imported into EndNote reference management software, merged, and exported as a single Refman (RIS) file. Duplicates will be removed automatically and manually to create a unique set of records, which will then be imported into Rayyan (<https://rayyan.ai/>) for screening.

To identify and include studies meeting the predefined eligibility criteria, a two-stage screening process will be employed (see screening decision tree; Appendix 2). At stage 1, two independent reviewers will screen titles and abstracts according to a prepared screening decision tree. At stage 2, full texts of records passing stage 1 will be obtained and assessed by two independent reviewers according to the screening decision tree. Studies meeting all criteria will be included, and exclusions (with reasons) will be documented. At both stages, studies that cannot be definitively included or excluded based on available information will be tagged as “Maybe” for further evaluation. Studies lacking extractable data or sufficient reporting will be excluded during full-text screening. Disagreements will be resolved through discussion or by a third reviewer. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram will be used to report study search, identification, screening, and inclusion.

## Data Extraction and Synthesis

The final included studies will undergo manual data extraction and tagging for evidence mapping and database curation, focusing on bibliographic data (e.g., publication type, title, DOI, year, journal) and exposure details (e.g., media type, sample location, sample collection year, sample extraction method, instrument used, pesticide information, statistical information). These data will be extracted and cross-checked by two independent reviewers, with final reviews for completeness, consistency, and robustness conducted by other authors. See Table 2 for detailed data extraction and abstraction codebook.

Overall, we will employ a combination of systematic evidence mapping (SEM) and bibliometric analysis, referred to as “research weaving,” to explore and summarize the included evidence. Research weaving enables the summarization and visualization of available evidence on a topic, providing a snapshot of the current state of knowledge, identifying research gaps, and highlighting areas ready for full synthesis (Nakagawa *et al.*, 2019). Accordingly, evidence will be mapped for the most studied pesticides, exposure sources and pathways, and spatiotemporal distributions, with gaps identified.

*Table 2: Data Extraction Codebook.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Data Category** | **Data Prompts** | **Description** | **Data Type** | **Guide** |
| **Study Information** | Title | The full title of the study or publication. | Text (string) | Copy directly from the publication's title page or abstract. If no title is available, use "Untitled" and note the reason. |
|  | DOI | The Digital Object Identifier (DOI) for the publication. | Text (string, e.g., "10.1234/example") | Extract from the publication metadata or database record. If unavailable, search Crossref or the journal website; enter "N/A" if not found. |
|  | Publication Type | The type of publication (e.g., peer-reviewed article, thesis, report, dataset). | Categorical (e.g., "Journal Article", "Thesis", "Grey Literature Report") | Determine from the source (e.g., journal name indicates "Journal Article"); classify based on predefined categories in your protocol (e.g., peer-reviewed vs. grey literature). |
|  | Journal | The name of the journal or publishing outlet (if applicable). | Text (string) | Copy from the publication details. For non-journal items (e.g., theses), enter the repository or institution name; use "N/A" for unpublished works. |
|  | Publication Year | The year the study was published. | Numeric (integer, e.g., 2020). | Take from the publication date. If only a range is given, use the earliest year; ensure it meets the 2000+ eligibility criterion. |
|  | Study ID | A unique identifier assigned to the study for internal tracking. | Text (string, e.g., "ETH-001"). | Assign sequentially during extraction (e.g., based on order of inclusion); combine with key details like author and year for uniqueness. |
| **Population/Location Information** | Study Area | The specific location(s) within Ethiopia where the study was conducted (e.g., region, city, ecosystem). | Text (string, e.g., "Amhara Region, Lake Tana"). | Extract from methods or results sections; list multiple if applicable. Must be Ethiopia-specific per eligibility criteria. |
|  | State/Region | The administrative state or region in Ethiopia (e.g., Oromia, Tigray). | Categorical (e.g., dropdown list of Ethiopian regions). | Identify from study description or maps; standardize to official Ethiopian regional names. If nationwide, enter "National". |
|  | Study Population | The target population (e.g., general population, rural dwellers, farming families). | Categorical (e.g., "General Population", "Vulnerable Groups - Children"). | Based on study aims; exclude if occupational only. Align with non-occupational focus (e.g., indirect exposure). |
|  | Exposure Type | The type of exposure pathway (e.g., multi-pathway, indirect environmental). | Categorical (e.g., "Indirect via Water", "Multi-Media Mixture"). | Infer from study focus; classify as "multi-pathway" if multiple media are involved, per protocol objectives. |
| **Sample Information** | Sample Media | The environmental media sampled (e.g., air, water, soil, food, house dust). | Categorical (e.g., "Soil", "Drinking Water"). | Extract from methods; list multiples if applicable. Must indicate indirect exposure per eligibility. |
|  | Sample Location | Detailed location of sample collection (e.g., coordinates, site description). | Text (string, e.g., "Rift Valley farmland, 9.0°N 38.7°E"). | Copy from methods or figures; geocode if possible for mapping. Tie to spatiotemporal gaps in synthesis. |
|  | Sample Collection Method | How samples were collected (e.g., grab sampling, composite sampling). |  | Extract from methods section; note if standardized (e.g., EPA protocols) or study-specific. |
|  | Sample Extraction Method | The method used to extract pesticides from samples (e.g., solid-phase extraction). | Text (string). | From analytical methods; include details like solvents used. If not reported, enter "Not Specified". |
|  | Detection Method/Instrument | The analytical instrument or method for detection (e.g., GC-MS, HPLC). | Text (string, e.g., "Gas Chromatography-Mass Spectrometry"). | Extract from methods; abbreviate standard terms. Note limits of detection if provided. |
|  | Sample Collection Year (Start) | The starting year of sample collection. | Numeric (integer, e.g., 2015). | From methods or results; use for temporal analysis. If range, split into start/end. |
|  | Sample Collection Year (End) | The ending year of sample collection. | Numeric (integer, e.g., 2018). | As above; if single year, duplicate start year here. |
| **Pesticide Information** | Pesticide Name | The specific pesticide(s) reported (e.g., DDT, glyphosate). | Text (string; list multiples separated by semicolons). | From results; include common and chemical names. Focus on multi-pesticide mixtures per objectives. |
|  | Pesticide Type | The category of pesticide (e.g., insecticide, herbicide, mixture). | Categorical (e.g., "Insecticide", "Herbicide Mixture"). | Classify based on study or standard classifications (e.g., WHO); note if multi-pesticide. |
| **Statistical/Outcome Information** | Concentration Levels | Quantitative measures of pesticide residues (e.g., mean mg/kg). | Numeric or text (e.g., "Mean: 0.5 mg/kg; Range: 0.1-1.0"). | Extract from results/tables; prioritize extractable data per eligibility. Include units. |
|  | Detection Frequency | Proportion or frequency of positive detections (e.g., 75% of samples). | Numeric (e.g., percentage or count). | From results; calculate if raw data provided. Use for gap identification. |
|  | Other Statistical Info | Additional stats (e.g., median, SD, predictors like environmental conditions). | Text (string, e.g., "Median: 0.3 μg/L; SD: 0.1"). | Summarize from results; note temporal variability or predictors for evidence mapping. |

# Piloting

The pilot search across all databases retrieved a total of 1,539 records, including an additional 50 studies identified through reference scanning of relevant studies and Google searches. The merged records were deduplicated using a two-stage process: initially, 250 duplicates were removed using the *synthesisr* R package (Westgate and Grames, 2020), followed by the removal of 20 more after importing to Rayyan. Ultimately, 1,248 records were retained. Screening was conducted on a randomly selected 10% of the records, resulting in 10 eligible studies for piloting data extraction and tagging (see Table 3).

Table 3:

# References

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Holder, C., DeLuca, N., Luh, J., Alexander, P., Minucci, J.M., Vallero, D.A., Thomas, K., *et al.* (2023), “Systematic Evidence Mapping of Potential Exposure Pathways for Per- and Polyfluoroalkyl Substances Based on Measured Occurrence in Multiple Media”, *Environmental Science and Technology*, Vol. 57 No. 13, pp. 5107–5116, doi: 10.1021/acs.est.2c07185.

Kalyabina, V.P., Esimbekova, E.N., Kopylova, K. V. and Kratasyuk, V.A. (2021), “Pesticides: formulants, distribution pathways and effects on human health – a review”, *Toxicology Reports*, Vol. 8, pp. 1179–1192, doi: 10.1016/j.toxrep.2021.06.004.

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Woodruff, T.J. and Sutton, P. (2014), “The Navigation Guide Systematic Review Methodology: A Rigorous and Transparent Method for Translating Environmental Health Science into Better Health Outcomes”, *Environmental Health Perspectives*, Vol. 122 No. 10, pp. 1007–1014, doi: 10.1289/ehp.1307175.

# Appendices

## Appendix A: List of benchmarking studies (n=35)

|  |  |  |
| --- | --- | --- |
| **No.** | **Title** | **DOI** |
| 1 | Biomagnification of DDT and its metabolites in four fish species of a tropical lake | 10.1016/j.ecoenv.2013.03.020 |
| 2 | Biological and chemical monitoring of the ecological risks of pesticides in Lake Ziway, Ethiopia | 10.1016/j.chemosphere.2020.129214 |
| 3 | DDT and Its Metabolites in Ethiopian Aquatic Ecosystems: Environmental and Health Implications | 10.1177/11786302241307471 |
| 4 | Pesticide concentration in three selected fish species and human health risk in the Lake Tana sub-basin, Ethiopia | 10.1007/s10661-023-11594-y |
| 5 | Pesticide residue levels in vegetables and surface waters at the Central Rift Valley (CRV) of Ethiopia | 10.1007/s10661-020-08452-6 |
| 6 | Apparent Khat chewers exposure to DDT in Ethiopia and its potential toxic effects: A scoping review | 10.1016/j.yrtph.2023.105555 |
| 7 | Organochlorine pesticides in Ethiopian waters: Implications for environmental and human health | 10.1016/j.toxrep.2024.06.001 |
| 8 | Qualitative assessment of 27 current-use pesticides in air at 20 sampling sites across Africa | 10.1016/j.chemosphere.2020.127333 |
| 9 | Levels of organochlorine pesticides in five species of fish from Lake Ziway, Ethiopia | 10.1016/j.sciaf.2022.e01252 |
| 10 | Pesticide Contamination of Surface and Groundwater in an Ethiopian Highlands’ Watershed | 10.3390/w14213446 |
| 11 | Exposure to DDT and its metabolites from khat (Catha edulis) chewing: Consumers risk assessment from southwestern Ethiopia | 10.1016/j.yrtph.2017.05.008 |
| 12 | Ecological risk assessment of organochlorine pesticides and polychlorinated biphenyls in water and surface sediment samples from Akaki River catchment, central Ethiopia | 10.1016/j.emcon.2020.11.004 |
| 13 | Concentrations and human health risk assessment of organochlorine pesticides in edible fish species from a Rift Valley lake-Lake Ziway, Ethiopia | 10.1016/j.chemosphere.2016.07.096 |
| 14 | Monitoring and risk assessment of pesticides in irrigation systems in Debra Zeit, Ethiopia. | 10.1016/j.chemosphere.2016.07.031 |
| 15 | Residue analysis of selected organophosphorus and organochlorine pesticides in commercial tomato fruits by gas chromatography mass spectrometry | 10.1016/j.heliyon.2023.e14121 |
| 16 | Assessment of pesticide residues in vegetables produced in central and eastern Ethiopia | 10.3389/fsufs.2023.1143753 |
| 17 | Analysis of organochlorine pesticide residues in human and cow's milk in the towns of Asendabo, Serbo and Jimma in South-Western Ethiopia | 10.1016/j.chemosphere.2012.09.008 |
| 18 | Organochlorine pesticides, polybrominated diphenyl ethers and polychlorinated biphenyls in surficial sediments of the Awash River Basin Ethiopia | 10.1371/journal.pone.0205026 |
| 19 | Persistent organochlorine pesticides residues in cow and goat milks collected from different regions of Ethiopia | 10.1016/j.chemosphere.2014.02.012 |
| 20 | Investigating the Spatial Trends in the Level of Organic Contaminants in the Ethiopian Rift Valley Lakes Using Semipermeable Membrane Devices | 10.1007/s00128-018-2358-9 |
| 21 | Levels and Trophic Transfer of Selected Pesticides in the Lake Ziway Ecosystem | 10.1007/s00128-022-03497-4 |
| 22 | Organochlorine pesticide residues in tea and their potential risks to consumers in Ethiopia | 10.1016/j.heliyon.2021.e07667 |
| 23 | Environmental and Human Health Risks of Pesticide Presence in the Lake Tana Basin (Ethiopia) | 10.3390/su142114008 |
| 24 | Concentrations and human health risk assessment of organochlorine pesticides in edible fish species from a Rift Valley lake-Lake Ziway, Ethiopia | 10.1016/j.ecoenv.2014.04.014 |
| 25 | Organochlorine pesticides and polychlorinated biphenyls in carnivorous waterbird and fish species from Lake Hawassa, Ethiopia | 10.1007/s42452-022-05177-8 |
| 26 | Exposure to DDT and HCH congeners and associated potential health risks through khat (Catha edulis) consumption among adults in South Wollo, Ethiopia | 10.1007/s10653-021-00846-w |
| 27 | Temporal Trends of Persistent Organic Pollutants across Africa after a Decade of MONET Passive Air Sampling | 10.1021/acs.est.0c03575 |
| 28 | Risk of DDT residue in maize consumed by infants as complementary diet in southwest Ethiopia | 10.1016/j.scitotenv.2014.12.087 |
| 29 | Pesticide Residues and Associated Public Health Risks in Vegetables from Irrigated Farms Adjacent to Rift Valley Lake Ziway, Ethiopia | 10.1155/2024/5516159 |
| 30 | Bioaccumulation of persistent organic pollutants (POPs) in fish species from Lake Koka, Ethiopia: The influence of lipid content and trophic position | 10.1016/j.scitotenv.2011.09.008 |
| 31 | Assessment of organochlorine pesticide pollution in Upper Awash Ethiopian state farm soils using selective pressurised liquid extraction | 10.1016/j.chemosphere.2008.03.041 |
| 32 | Organochlorine pesticides in bird species and their prey (fish) from the Ethiopian Rift Valley region, Ethiopia | 10.1016/j.envpol.2014.05.007 |
| 33 | Occurrence, distribution, and ecological risk assessment of DDTs and heavy metals in surface sediments from Lake Awassa-Ethiopian Rift Valley Lake | 10.1007/s11356-013-1821-8 |
| 34 | Organochlorine, organophosphorus, and carbamate pesticide residues in an Ethiopian Rift Valley Lake Hawassa: occurrences and possible ecological risks | 10.1007/s11356-024-32848-3 |
| 35 | Levels of organochlorine pesticides in onion and tomato samples from selected towns of Jimma Zone, Ethiopia | 10.1016/j.heliyon.2024.e35033 |

*Search string validated for Scopus (sensitivity = 100%)*

( ( TITLE-ABS-KEY ( pesticide OR agrochemical OR insecticide OR fungicide OR herbicide OR organochlorine OR ocp OR ddt ) AND TITLE-ABS-KEY ( pollution OR exposure OR monitoring OR concentration OR level OR residue OR contamination OR air OR soil OR water OR food ) AND TITLE-ABS-KEY ( ethiopia ) AND NOT TITLE-ABS-KEY ( mosquito\* ) ) ) AND ( ( DOI ( "10.3389/fsufs.2023.1143753" ) OR DOI ( "10.1371/journal.pone.0205026" ) OR DOI ( "10.1016/j.scitotenv.2011.09.008" ) OR DOI ( "10.1016/j.ecoenv.2013.03.020" ) OR DOI ( "10.1007/s00128-018-2358-9" ) OR DOI ( "10.1016/j.chemosphere.2020.127333" ) OR DOI ( "10.1007/s10653-021-00846-w" ) OR DOI ( "10.1016/j.chemosphere.2012.09.008" ) OR DOI ( "10.1016/j.heliyon.2024.e35033" ) OR DOI ( "10.1016/j.emcon.2020.11.004" ) OR DOI ( "10.1007/s10661-020-08452-6" ) OR DOI ( "10.1016/j.scitotenv.2014.12.087" ) OR DOI ( "10.1016/j.chemosphere.2016.07.096" ) OR DOI ( "10.1016/j.yrtph.2017.05.008" ) OR DOI ( "10.1177/11786302241307471" ) OR DOI ( "10.1016/j.chemosphere.2020.129214" ) OR DOI ( "10.1007/s00128-022-03497-4" ) OR DOI ( "10.1016/j.heliyon.2021.e07667" ) OR DOI ( "10.3390/w14213446" ) OR DOI ( "10.1016/j.chemosphere.2016.07.031" ) OR DOI ( "10.1016/j.chemosphere.2008.03.041" ) OR DOI ( "10.1021/acs.est.0c03575" ) OR DOI ( "10.1016/j.heliyon.2023.e14121" ) OR DOI ( "10.1007/s11356-013-1821-8" ) OR DOI ( "10.1016/j.ecoenv.2014.04.014" ) OR DOI ( "10.1016/j.envpol.2014.05.007" ) OR DOI ( "10.1016/j.yrtph.2023.105555" ) OR DOI ( "10.1007/s10661-023-11594-y" ) OR DOI ( "10.3390/su142114008" ) OR DOI ( "10.1016/j.toxrep.2024.06.001" ) OR DOI ( "10.1016/j.sciaf.2022.e01252" ) OR DOI ( "10.1007/s42452-022-05177-8" ) OR DOI ( "10.1007/s11356-024-32848-3" ) OR DOI ( "10.1155/2024/5516159" ) OR DOI ( "10.1016/j.chemosphere.2014.02.012" ) ) )

## Appendix 2: Screening Decision Tree

**Stage 1: Title/Abstract Screening**

1. Is the study conducted in or reporting data specific to Ethiopia (e.g., any region, urban/rural setting, or ecosystem within the country, including Ethiopia-specific data from multi-country analyses)?

* No → EXCLUDE.
* Yes/Maybe → Continue.

1. Does the study focus on the general population in Ethiopia (e.g., non-occupational groups such as residents, consumers, communities, or subpopulations like farming families or vulnerable groups exposed via indirect environmental routes)?

* No (e.g., exclusively occupational or non-human populations) → EXCLUDE.
* Yes/Maybe → Continue.

1. Does the study report on pesticide residues, levels, or occurrence in environmental surrogate media (e.g., air, water, soil/sediment, food, house dust) indicating indirect exposure pathways?

* No (e.g., solely occupational exposure, pesticide efficacy trials, or direct biomonitoring without media linkage) → EXCLUDE.
* Yes/Maybe → Continue.

1. Does the study provide extractable data on pesticide residues/levels (e.g., quantitative measurements like mg/kg or μg/L, or qualitative detection frequency) that could support evidence mapping or database curation?

* No (e.g., no residue data, only health effects without exposure measurements) → EXCLUDE.
* Yes/Maybe → Continue.

1. Is the study a primary research article or grey literature (e.g., monitoring, observational, or modeling studies with empirical media measurements, theses, reports, or datasets)?

* No (e.g., non-empirical studies like editorials, commentaries, protocols without data, or mosquito control interventions without relevant residues) → EXCLUDE.
* Yes/Maybe → Continue.

1. Does the publication date appear to be from January 1, 2000, onward (or potentially earlier if highly relevant)?

* No → EXCLUDE.
* Yes/Maybe → Continue to Stage 2.

**Stage 2: Full-Text Screening**

1. Is the full text accessible (in English or a local language the authors can understand and translate, e.g., Amharic)?

* No → EXCLUDE.
* Yes → Continue.

1. Does the study confirm Ethiopia-specific data extraction is possible, and is it free of high risk of bias or poor quality that prevents reliable data extraction (assessed per OHAT and Navigation Guide frameworks)?

* No → EXCLUDE.
* Yes → Continue.

1. Does the study confirm focus on the general (non-occupational) population in Ethiopia, with indirect exposure pathways (e.g., no exclusive focus on occupational groups or non-humans)?

* No → EXCLUDE.
* Yes → Continue.

1. Does the study report pesticide residues/levels in eligible environmental media (e.g., air, water, soil, food), including any pesticide types (e.g., insecticides, herbicides, mixtures), with pathways suggesting indirect exposure?

* No (e.g., no media measurements, solely occupational, or unrelated interventions like mosquito control without relevant residues) → EXCLUDE.
* Yes → Continue.

1. Does the study provide sufficient, extractable outcome data (e.g., residues/levels, sources, routes, temporal variability, predictors) for evidence mapping, gap identification, and database curation?

* No (e.g., no extractable data, only health effects without exposure details) → EXCLUDE.
* Yes → Continue.

1. Does the study design and type align with eligibility (e.g., primary monitoring/observational studies, modeling with empirical data, or grey literature with residue details; published 2000 onward, or exceptionally relevant earlier studies)?

* No (e.g., non-empirical, modeling without empirical data, or pre-2000 without high relevance) → EXCLUDE.
* Yes → INCLUDE.