

Appendix 1: Reviewed research on farmer knowledge of soil fauna in agricultural contexts.

Table A1.1: List of studies used to compile the worldwide map of reported local farmer knowledge of soil fauna in agricultural contexts (Figure 1)

Author	Focal Soil Fauna Taxa [‡]	Location	Description of people and agroecosystem	Practical application or underlying motivation of study
Adjei-Nsiah <i>et al.</i> (2004)	Earthworms, termites	Village of Asuoano, Wenchi District, Brong-Ahafo region, Ghana.	Indigenous Akan people, and migrant Lobi, Wala and Dagaba people. Smallholder farmers with main crops maize, cassava, yam, cocoyam, pigeon pea, plantain, cowpea and groundnut. Forest-savannah transitional agro-ecological zone.	Explore farmers' soil fertility management practices and their relevant social context (including comparing migrant farmers with local/Indigenous farmers), to ground future action research in the needs of the local farming community.
Ali (2003)	Earthworms	Damarpota village, floodplain of the Betravati (Betna) river, southwestern Bangladesh	Smallholder saline wet rice ecosystem; tropical monsoon climate with three cropping seasons. Main crops three varieties of rice, plus jute, vegetables and oilseeds.	Quantifying farmers' knowledge and comparing with scientific data to provide evidence that farmers' substantial knowledge should be used in agricultural development policies and in national scientific databases.
Atwood (2010)	Multiple	'Thumb' region of Michigan state (Huron, Sanilac, Tuscola and Lapeer counties), USA	Family farms growing multiple crops including soybeans, corn, sugarbeets, dry beans, and winter wheat, with some livestock	Compare and characterise the worldviews of organic and non-organic farmers through their observations of crop and soil health, perceptions of soil quality indicators and agricultural management information channels.
Audeh <i>et al.</i> (2011)	Multiple	Localities surrounding town of Canguçu, Rio Grande do Sul state, Brazil	Smallholder tobacco farmers in environmentally sensitive areas with shrub vegetation	Promote soil quality knowledge and derive a set of indicators to evaluate the effect of land use, management and soil conservation
Barrera-Bassols (2003)	Multiple	Lake Pátzcuaro basin, central Mexican volcanic highlands, Michoacán State, west Mexico	Purhépecha people. Smallholder agriculture based on milpa production, main crop maize. Temperate subhumid to cold humid climate.	Ethnopedological study with a view towards understanding decision-making by local people. Extremely detailed covering soil taxonomy and ethnoecology.
Barrios and Trejo (2003)	Earthworms	Tascalapa watershed, Yoro, Central Honduras	Smallholder hillside farmers using 'slash and burn' agriculture to produce maize and beans.	Description of approaches for eliciting local soil knowledge using case studies with view to developing integrated soil management based on local and scientific knowledge
Bentley and Rodríguez (2001) [†]	Multiple	Rural Honduras, further detail not specified	Honduran <i>campesinos</i> , further detail not specified.	Development of conceptual framework for understanding folk entomological knowledge using case study approach
Birang <i>et al.</i> (2003) [†]	Earthworms	Humid forest, southern Cameroon	Beti people of southern Cameroon. Smallholder agriculture using 'slash and burn' cultivation of forest and fallow. Mixed crops including groundnut, cassava, maize, plantain, cocoyam and cacao.	Ascertaining 'baseline' farmer perceptions and knowledge as a means of predicting local attitudes towards alternative farming systems.
Birmingham (2003)	Termites, earthworms	Equatorial forest zone, southern Côte d'Ivoire and savannah zone, northern Côte d'Ivoire	Bété people of the equatorial forest zone and Senufo people of the guinea-savanna zone. Bété practice slash-and-burn for food crops (staple crop rice), and tree cash crops including coffee and cocoa. Senufo practice longer fallows with food crops (staple crop rice), and cotton cash crop	Describe local knowledge of soil types and compare with scientific data with view to improving research and extension efforts.
Buthelezi (2010)	Earthworms, 'soil mesofauna'	uMbumbulu region, KwaZulu-Natal province, South Africa	Smallholder farmers cultivating <i>amadumbe</i> (taro), maize, sweet potatoes and potatoes	Investigate the use of Indigenous knowledge in farming, as well as farmers' perceptions and assessments of soil fertility (scientific measurements of soil properties were also made)

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Carter and Murwira (1995)	Termites	Mutoko communal area, northeast Zimbabwe	Smallholder agriculture, mixed crops including maize, millet, sorghum, cowpeas, groundnuts, sunflower, rice and vegetables. Cattle grazing on communal lands.	Exploration of the methods used by farmers to exploit edaphic variability for crop and soil management.
Cerón Rengifo <i>et al.</i> (2003)	Multiple	Potrerrillo watershed in Cauca, Colombia; Andes Cordillera (1400-1500 masl)	Smallholder farmers cultivating coffee, banana, yucca, maize, beans, green tomato, sugar cane and some fruits	Relate local soil classifications to measurements of chemical, physical and biological characteristics.
Chandola <i>et al.</i> (2011)	Beetle larvae	Bageshwar district of Uttarakhand state, India	Smallholder farmers growing irrigated rice, and rain-fed crops (wheat, dry rice). Western Himalayan region.	Document traditional and Indigenous pest management practices that do not rely on application of synthetic chemicals
Dai Trung <i>et al.</i> (2008)	Earthworms	Tan Lac district, Hoa Binh province, mountain karst in northern Vietnam	Muong ethnic group. Smallholder agriculture on small plots on mountain slopes and in stream valleys, staple crop rice.	Documentation of ethnopedological knowledge and validation of local soil fertility indicators using scientific data
Dawoe <i>et al.</i> (2012)	Multiple	Ashanti region, semi-deciduous forest, western Ghana	Majority Indigenous Akan-speaking people. Smallholder agriculture, crops include maize.	Understanding and integrating farmer and scientific knowledge to facilitate improved nutrient cycling.
Desbiez <i>et al.</i> (2004)	Multiple	Pakuwa village, Parbat District, mid-hills of western Nepal	Brahmin and Chhetri ethnic groups. Terraced agricultural land ranging 850-1500 m, including: 'lowland' irrigated terraces, 'upland' rainfed terraces, kitchen gardens and pasture. Main crops wheat, potatoes, maize, rice, millet.	Understanding and integrating farmer and scientific knowledge to facilitate improved soil fertility management.
Deschamps and Demeulenaere (2015) [†]	Multiple	Departments of Vendée, Marne and Eure, France	Farmers participating in the <i>L'Observatoire Agricole de la Biodiversité</i> (Agricultural Biodiversity Observatory), a voluntary citizen science and 'participatory ecology' program under the guidance of the Ministry of Agriculture	Understand farmer adoption of observations of agricultural biodiversity (measures included the abundance of earthworms to indicate soil quality, and the number of terrestrial invertebrates accumulating under planks of wood left on the ground to indicate resilience to pest attacks).
Dix (1997) [†]	Beetle larvae	Chilasco village, highlands of Baja Verapaz department, eastern Guatemala (1840 masl)	Smallholder growers of broccoli (cash crop) and corn; secondary crops include beans, potatoes, red peppers, cabbage, squash. Transition zone between mixed conifer and broadleaf cloud forest in the buffer zone of the Sierra de las Minas Biosphere Reserve.	Determine the relationship between pest (white grub / beetle larvae) abundance and organic matter amendments, guided by farmers' practices and beliefs as to what influenced the presence of white grubs, with view to developing more effective integrated pest management strategies.
Ericksen and Ardon (2003)	Earthworms, beetles	La Lima watershed, central Honduras	Farmers of mixed Indigenous and Spanish descent. Mixed smallholder agriculture including beans, corns, horticultural crops with some coffee groves (some shaded with fruit trees) and pastures.	Comparison of interpretation of local farmers' knowledge and soil scientist's knowledge to find 'common ground' between two understandings (not validate)
Grossman (2003) [†]	Multiple	Highland and lake regions of Chiapas state, Mexico	Indigenous Mayan peasants in highland region (Tzeltal and Tzotzil speakers) and Spanish speakers in lake region. Small-scale organic coffee producers.	Assessment of farmer understanding of soil fertility enhancement processes in decision-making and experimentation in context of assessing gaps in knowledge for training programmes.
Gruver and Weil (2006)	Earthworms	States of Maryland, Delaware, Pennsylvania, Virginia, West Virginia, Mid-Atlantic USA	Farmers interested in soil conservation. Range of farm sizes included e.g. cash grains 20-2800 ha, dairy 70-2260 ha. Mixed enterprises including grains, vegetables, hay, livestock.	Participatory definition of soil quality benchmarks using farmer judgements of soil quality and individual soil parameters.

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Gurung (2003) [†]	Multiple	Dang-Deukhuri district, subtropical lowlands (Terai) of Nepal	Tharu people. Smallholder agriculture, main crops include maize, rice, wheat, mustard seed. Livestock reared at homesteads.	Ethnoentomological study with application to improve efficacy and acceptance of pest management programmes.
Joshi and Singh (2006)	Earthworms, beetle larvae	Eight villages from Almora and Nainital districts, representing valleys and uplands in the hills of Uttaranchal, western Himalayas, India	Smallholder low input systems with crops, horticulture, livestock, forestry and animal husbandry	Document traditional agricultural practices in low-input agricultural system.
Kelly <i>et al.</i> (2009)	Earthworms, beetles	Billabong catchment, southern New South Wales, southeast Australia	Dryland broadacre cropping and grazing, further details not specified.	Understand how farmers use soil indicators to inform management decisions with view to improving soil health projects and empowering farmers.
Kipkorir (2015) [†]	Multiple	Six villages surrounding Kiberashi Sentinel Site, <i>miombo</i> woodlands, Tanzania	Smallholder mixed subsistence farming; main crops include maize and beans, with mixed livestock including cattle, goats, sheep, donkeys	Elicit farmers' knowledge of indigenous tree species, soil macrofauna and their interactions, and use these relationships to guide scientific sampling of soil properties and soil fauna around trees.
de Lima <i>et al.</i> (2011)	Earthworms	Camaquã county, coastal plains of Rio Grande do Sul state, southern Brazil	Rice farmers cultivating fields ranging from 2-500 ha; majority small landholders descended from German and Polish settlers arrived late 19 th C. Families were formerly landless and granted land from the early 1960s.	Determine locally important soil quality indicators and their use in land management.
Lobry de Bruyn and Abbey (2003)	Multiple	Northwest cropping region of New South Wales, southeast Australia	Range of farm sizes from 66 to 30 000 ha. Grain-growing region. Representative sample of farmers in the region.	Developing a prototype collaborative farmer's soil health checklist with aim of empowering farmers to be more self-reliant.
Mairura <i>et al.</i> (2007)	Multiple	Chuka and Gachoka divisions, central Kenya highlands	Intensively managed smallholder farms typically with cereal-legume intercrops for home consumption, market crops, livestock and kitchen gardens.	Determine farmers' perceptions of soil quality and soil management practices, and compare with soil physical and chemical properties to assess local soil fertility indicators.
Malaret and Ngoru (1989) [†]	Termites	Mbiuni location, Machakos district, Kenya	Akamba people. Smallholder farmers growing maize intercropped with beans, cowpeas or pigeon peas, and grazing. Indigenous trees left within crop lands for fodder, timber and fuel. Transitional zone from sub-humid to semi-arid climate.	Determine scope and relevance of Indigenous knowledge of termite ecology for pest control in agricultural and agroforestry production systems.
M'Biandoun and Olina Bassala (2007)	Multiple	Four villages in northern Cameroon (Mowo, Gadas, Mafa Kilda, Fignolé)	The four villages differ in ethnicity, climate, geomorphology & soils and population density. Doayo, Mafa, Moundang and Mofou people. Smallholder farmers with main crops including cotton, maize, sorghum, <i>muskwari</i> (dry season sorghum). Annual rainfall between 700-1500 mm.	Understand how farmers assess the fertility of their land and capacity of farmland to produce crops; criteria included biophysical indicators and the productivity of labour for particular crops.
Mielke and Mielke (1982)	Termites	Southwest Tanzania	Smallholder chitemene agriculture (slash-and-burn cultivation with pollarded trees; fields have a circular form). Detail on farmers not given.	Statistical analysis of spatial association between termite mounds and field locations, emphasising that the importance of termites in traditional agricultural practices is at odds with recent efforts to 'control' termites.

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Miyagawa <i>et al.</i> (2011) [†]	Termites	Dong Khuai village, Vientiane Plain, Laos	Lao speakers. Smallholder agriculture, rainfed lowland rice production (paddy fields and upland areas) with some fish farming adjacent to paddy fields (termites used as fish feed).	Determine the sustainability of the use of termite mounds by rice farmers.
Morales and Perfecto (2000) [†]	Multiple	Community of Patzún, Chimaltenango Department, Guatemalan highlands (2000 ⁺ masl)	Cazchiquel Maya farmers. Smallholder agriculture based on traditional <i>milpa</i> (maize polyculture with combinations of climbing beans, fava beans and squash) and non-traditional export crops (broccoli, snow peas, zucchini)	Understanding farmers' agricultural knowledge as first step to design a more participatory, effective research process in integrated pest management.
Mugerwa <i>et al.</i> (2011) [†]	Termites	Nakasongola District, semi-arid rangelands of central Uganda	Smallholder farmers involved in livestock grazing (majority cattle) with some crop production	Investigate farmer's traditional ecological knowledge of termites to develop appropriate termite control strategies.
Murage <i>et al.</i> (2000)	Earthworms, beetle larvae	Kiambu District, central Kenya highlands	Smallholder agriculture, mixed crops (cereal-legume intercrops for home consumption) established in cleared afro-montane forest or evergreen bushland.	Identification of indicators of soil fertility status (based on soil sample analysis) consistent with farmers' perceptions of soil fertility with view to developing simple indicators of soil fertility to assess land management interventions.
Nezomba <i>et al.</i> (2015)	Millipedes, earthworms, ants	Nyahava ward in Makoni and Goto ward in Hwezda, eastern Zimbabwe	Smallholder farmers growing maize as principal crop, with food legumes (e.g. groundnut) and cowpea.	Investigate farmers' knowledge of soil degradation and the commonly used local diagnostic indicators, as an entry point for developing locally-appropriate integrated soil fertility management using legume cover crops
Nhamo (2007) [†]	Multiple	Shamva (north-eastern Zimbabwe) and Zimuto areas (Southern Zimbabwe)	Smallholder farmers operating within a communal tenure system. Mixed farming with crops (maize for subsistence, cash crops, small grains, legumes) and livestock. Open <i>miombo</i> savanna vegetation from sub-humid and semi-arid climates.	Understand how the farmers' knowledge of soil fauna was linked with patterns of residue utilisation by farmers in conservation agriculture.
Nyeko and Olubayo (2005)	Termites	Tororo district, eastern Uganda	Majority Japadhola and Itesot ethnic groups, smallholder farmers. Staple food crops cassava, millet, maize and sorghum, with oil seed crops such as groundnuts, sesame and sunflower, as well as beans, cowpeas. Mixed livestock. Dry sub-humid lowlands (900-1300 mm bimodal rainfall). Agroforestry promoted in district for wood production, soil fertility management, tree products, fodder production.	Document and examine farmers' indigenous knowledge of termites (as a little explored topic), with the aim of developing and promoting locally appropriate and relevant integrated termite management in agroforestry.
Ortiz-Espejel <i>et al.</i> (1999) [†]	Earthworms	Northern, central and southern regions of Veracruz State, Mexico	Totonaco, Nahuatl and Zoque-Popoluca ethnic groups. Smallholder agriculture, further detail on farming systems not detailed.	Ethnological survey of knowledge of earthworm activity in relation to soil fertility, with a view to understanding whether local beliefs will support management practices focused on increasing earthworm populations.
Ortiz-Espejel <i>et al.</i> (2009) [†]	Earthworms	Four countries: Mexico, state of Veracruz (localities Papantla, Vega de Alatorre y Medellín), Peru (Yurimaguas), India (Yarpadi) and Congo (Niari Valley)	Pastures under management by indigenous people in each location.	Understand whether farmers' traditional knowledge relates earthworms to soil fertility.

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Pauli <i>et al.</i> (2012)	Multiple	Lempira Department, tropical dry forest on rugged terrain (~400-900 masl), southern Honduras	Farmers of mixed descent (Indigenous Lenca and Spanish colonists). Smallholder agriculture based on slash-and-mulch of <i>milpa</i> (maize, beans, sorghum, mixed livestock)	Understanding how farmers incorporate knowledge of native species and ecological processes into land management, with view to deriving principles for promoting high-biodiversity farming systems elsewhere.
Payton <i>et al.</i> (2003)	Termites	Lowlands of Sukumaland, Lake Victoria catchment, northwest Tanzania	Sukuma ethnic group (Tanzania) and Iteso people (Uganda). Smallholder agriculture, main crops maize, sorghum, cowpeas, groundnuts with some rice and cotton.	Exploration of methods for eliciting Indigenous soils knowledge and integrating Indigenous and scientific knowledge for soil survey and mapping.
	Earthworms	Lake Kyoga catchment, southeast Uganda		
Pincus (2015)	Earthworms	Villages surrounding Nkokonjeru town, Lake Victoria Crescent region, Uganda	Smallholder farmers (Baganda people) growing a mix of subsistence (maize, cassava, potatoes, groundnuts, vegetables) and cash crops (banana, coffee), with some livestock. Experimental plots growing <i>nakati</i> (<i>Solanum aethiopicum</i>), an indigenous leafy green vegetable.	Understand the similarities and differences between farmers' and scientists' knowledge and perceptions of integrated soil fertility management (ISFM), through designing educational program to teach ISFM principles to farmers, and interviewing farmers before and after taking part in the program.
Posey (1985)	Termites, ants	Indian Post of Gorotire, largest of the northern Kayapo villages, Amazon Basin	Indigenous Kayapó cultivating forest 'islands' (apêtê) within campo/cerrado (tropical savannah) ecosystem, Brazilian Amazon Basin.	Document forest management practices of the Kayapó, situated within an ethnoecological framework. Emphasises importance of indigenous knowledge for conservation and productivity.
Price (2001) [†]	Multiple	Central Luzon, Philippines	Smallholder agriculture, rice cultivation.	Determining change in pest management knowledge before and after two different interventions.
Romig <i>et al.</i> (1995)	Earthworms	Southeast Wisconsin, USA	Conventional and low-input cash grain and dairy farms ranging in size from 80 to 2,200 ha; participants associated with a research project on integrated cropping systems	Understanding farmers' assessment of soil health, with view for development of soil health scorecard based on farmers knowledge and potential for integrating knowledge.
Roose <i>et al.</i> (1999) [†]	Termites	Yatenga and Passore provinces, Mossi plateau, northern Burkina Faso.	Subsistence farming based on cereals, peanuts, sesame and niébé (cowpea). Sudano-Saharan shrub-savanna with 6-8 month dry season.	Determine potential of 'zai' practice to restore soil fertility in degraded areas (method relies on action of termites to break up soil crusts, create galleries and allow water infiltration.)
Rousseau <i>et al.</i> (2013) [†]	Multiple	Chinandega department, tropical dry forest region of western Nicaragua	Smallholder agriculture encompassing a range of land use management, including traditional cropping, slash-and-mulch agroforestry and silvopastoral systems. Maize, beans.	Identification of soil invertebrates that could act as indicator taxa of soil quality with a view to evaluating land management impacts.
Saïdou <i>et al.</i> (2004)	Earthworms	Atacora and Savé regions of Benin	Majority Ditammari ethnic group (Atacora) and Tchabé and Peulh people (Savé), with other ethnic groups and migrants. Smallholder agriculture with crop rotation and intercropping up to four years after forest clearance, followed by planting cashew trees. Crops include yam, cotton, groundnut, sorghum, maize, cowpea, cassava and <i>egusi</i> melon.	Understanding how farmers have adapted cropping systems to the local environment (including local experimentation) with view to developing interactive research framework for testing effectiveness and applicability of local innovations not well understood by conventional science.
Saïdou <i>et al.</i> (2008) [†]	Earthworms	Transitional agro-ecological zone of Benin	Indigenous Tchabé people and migrants from elsewhere in Benin. Earthworm abundance sampled in smallholder fields planted with cassava, <i>egusi</i> melon, cowpea and maize.	Participatory research on farmer perceptions of earthworm activity in different crops.

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Saleque <i>et al.</i> (2008)	Earthworms, mole crickets	Moulvibazar and Habiganj districts, eastern Bangladesh	Smallholder rice production with three growing seasons per year.	Compare farmers' perception of soil fertility with laboratory soil tests to develop an improved nutrient management programme based on both views.
Schiavon <i>et al.</i> (2015) [†]	Multiple	District of Rincão da Caneleira, Morro Redondo, Rio Grande do Sul, Brazil	Family farm practising 'ecological' horticulture	To determine the potential use of local knowledge for assessing the influence of management practices on soil fauna
Sileshi <i>et al.</i> (2008) [†]	Termites	Central and southern Malawi Northern Mozambique Eastern Zambia	Majority Chewa and Ngoni ethnic groups. Smallholder agriculture (staple crop maize) with pilot study of an agroforestry development project	Understanding farmers' Indigenous knowledge as basis for constructive collaboration in pest management
Sillitoe (1995) [†]	Multiple	Haelaelinja region, Was (Wage) river valley, Nipa District, southern highlands of Papua New Guinea	Wola people. Montane forest and cane grasslands. Shifting cultivation of gardens; some maintained for decades. Major crop sweet potato.	Ethnoscience investigation into local knowledge of organic matter decomposition to further understanding of this understudied topic.
Tabu <i>et al.</i> (2003) [†]	Multiple	Kabras division, western Kenya	Smallholder maize/sugarcane cropping system in densely populated area.	Identification of soil macrofauna abundance and diversity in farmer-perceived soil fertility niches.
Tesfahunegn <i>et al.</i> (2011)	Earthworms	Mai-Negus catchment, Tigray region, northern Ethiopia	Smallholder agriculture with farmers representing a range of self-identified wealth categories. Major crop teff (<i>Eragrostis tef</i>) with pasture.	Local community diagnosis of soil quality to assess the contribution of local knowledge to strategies for sustainable developing decision-making, in context of scarce scientific information and relevance of local information.
Van Dang (2007)	Earthworms	Thai Nguyen region, northern mountains of Vietnam	Tea production as a cash crop in upland regions.	Identification of appropriate indicators for soil quality assessment using quantitative and qualitative (local knowledge) approaches with view to improve management.
Van Mele <i>et al.</i> (2001) [†]	Multiple	Mekong Delta, southern Vietnam	Mango orchards, two-thirds were <0.5 ha in size.	Understanding farmers' knowledge, perceptions and practices in pest management with view to improving management practices and pesticide use.
Wyckhuys and O'Neil (2007) [†]	Multiple	Upper Choluteca watershed, southeast Honduras	Smallholder farmers representative of rural Honduran villages. Subsistence farming based on maize, with some coffee and vegetable production.	Determine role of local knowledge in pest management and understand role of training in influencing knowledge.
Zúñiga <i>et al.</i> (2013) [†]	Earthworms	La Vieja River watershed, west central Colombia	Mosaic of land use patches including pastures, coffee, sugar cane, plantain, cassava, fruit trees, shaded coffee, forest and native bamboo.	Documenting farmer perceptions of earthworms, and integrating local and scientific knowledge to facilitate communication and education.

Notes:

† Denotes paper with a substantial focus on soil biology or invertebrates

‡ Focal soil fauna taxa only mentioned for summary purposes. See main text for indication of which papers mentioned other elements of the soil biota such as fungi and bacteria. 'Multiple' means four or more different taxa were addressed in some detail. Note that for many papers, soil biota were not the primary focus of the paper; this column highlights the soil fauna taxa that were mentioned by the authors

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